

NASA CR-156660

VOLUME 2
STRESS ANALYSIS

FRACTIONAL WATT
VUILLEUMIER CYROGENIC
REFRIGERATOR PROGRAM
ENGINEERING NOTEBOOK

74-9896-2

January 1974

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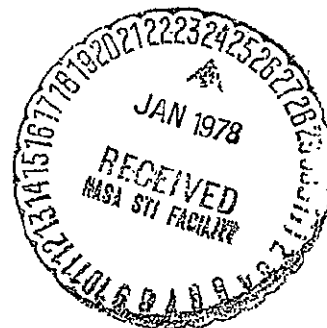
Prepared under Contract No. NAS 5-21715

for

National Aeronautics and Space Administration
Goddard Space Flight Center
Greenbelt, Maryland



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STRESS ANALYSIS

2

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FOREWORD

Under NASA Contract NAS 5-21715, the AiResearch Manufacturing Company, a Division of The Garrett Corporation, developed a 65°K Vuilleumier (VM) cryogenic refrigerator for the NASA Goddard Space Flight Center (GSFC), Greenbelt, Maryland. During the program, thermal analysis and stress analysis notebooks were compiled for submittal to GSFC. This two-volume document contains (or references) all material compiled during the course of the thermal and stress analyses. In certain instances, copyrighted reference material was used during the analytical work and will not be reproduced in this document.

Volume 1, identified as AiResearch document 74-9896-1, presents the detailed thermal analysis that was conducted during the program.

Volume 2, identified as AiResearch document 74-9896-2 presents the detailed stress analysis that was conducted during the program on various component parts/assemblies of the VM refrigerator.



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SECTION 1
INTRODUCTION

SECTION 1

INTRODUCTION

A structural analysis was performed on the 1/4-watt Vuilleumier (VM) cryogenic refrigerator developed for the NASA Goddard Space Flight Center. The analysis covered the complete assembly except for the cooling jacket and mounting brackets. Maximum stresses, margins of safety, and natural frequencies were calculated for structurally loaded refrigerator components shown in assembly drawing 852522.

The stress analysis indicates that the VM design is satisfactory for the specified vibration environment, and the proof, burst, and normal operating loads.

The organization and content of the Stress Analysis Engineering Notebook is summarized below:

- Section 2 Stress Analysis Summary - Overviews and summarizes the stress analysis effort performed during design and development of the VM refrigerator.
- Section 3 Design Requirements - Summarizes design requirements specified by NASA GSFC that were the basis for VM refrigerator preliminary design.
- Section 4 Material Properties - Reproduces AiResearch material specifications and information used in design/stress analysis of VM. References copyrighted vendor materials specifications.
- Section 5 Crankshaft Assembly - Stress analysis of the complete shaft assembly including wristpin, and connecting rod, and critical speed analysis of the assembly.
- Section 6 Crankshaft Housing - Analysis covers the spherical dome-cylinder intersection, sump cross tube intersection, motor inner housing, motor outer housing, and flanged connections.
- Section 7 Hot-End Pressure Shell - Analysis covers shell stresses and deflections, flange connection, and vacuum jacket.
- Section 8 Cold-End Pressure Shell - Analysis covers shell stresses and deflections, flange connection, and vacuum jacket.



- Section 9 Hot-End Displacer - Analysis covers collapsing pressure calculation and shell stresses and deflections.
- Section 10 Cold-End Displacer - Analysis covers collapsing pressure calculation and shell stresses and deflections.



SECTION 2
STRESS ANALYSIS SUMMARY

SECTION 2

STRESS ANALYSIS AND MECHANICAL DESIGN

INTRODUCTION

This section summarizes the structural analysis performed on the 1/4-watt Vuilleumier (VM) Cryogenic Refrigerator developed for the NASA Goddard Space Flight Center. The analysis covered the complete assembly except for the cooling jacket and mounting brackets. Maximum stresses, margins of safety, and natural frequencies were calculated for structurally loaded refrigerator components shown on the final assembly drawing 852522.

The structural analysis indicates that the VM design is satisfactory for the specified vibration environment, and the proof, burst, and normal operating loads.

STRESS ANALYSIS

Stress analysis performed on the 1/4-watt Vuilleumier (VM) cryogenic refrigerator covered the complete assembly except for the cooling jacket and mounting brackets. Maximum stresses, margins of safety, and natural frequencies were calculated for structurally loaded refrigerator components shown in the final assembly drawing (Figure 2-1).

VM Description

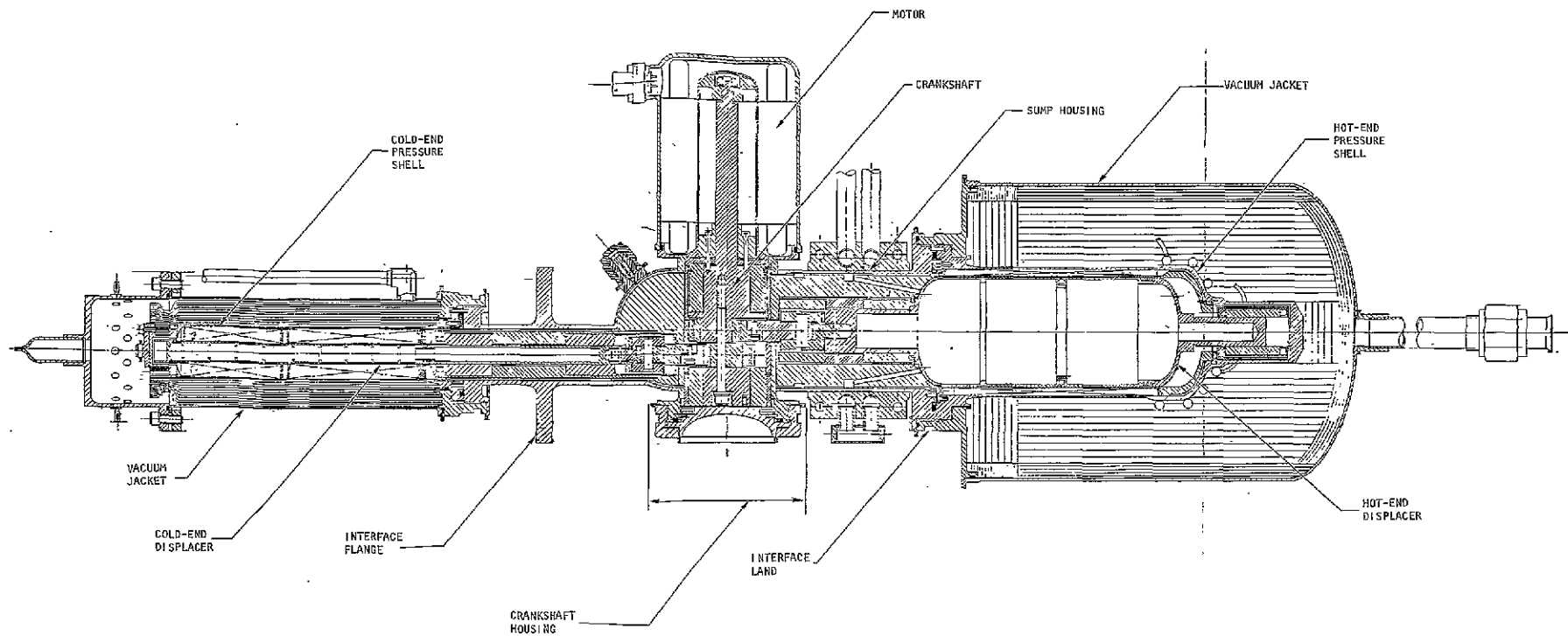
A brief description of the VM refrigerator is given here to aid in understanding the analytical summary which follows. A cross-sectional drawing of the VM refrigerator is presented in Figure 2-1.

1. VM Refrigerator

The VM refrigerator is a cryogenic refrigerator machine with a design speed of 400 rpm and a continuous operation design life of two years minimum. Moving components within the machine consist of a crankshaft attached assembly which drives two displacers (one hot, one cold) attached to the crankshaft with connecting rods. Crankshaft throws are 90 degrees apart with the hot displacer leading. The displacers travel inside of packed-bed regenerators that are enclosed in pressure shells joined to the crankshaft housing. Thus, the entire assembly forms a pressure-tight enclosure. The operating gas in the enclosure is helium. The crankshaft is driven by an electric motor.

FOLDOUT FRAME 1

FOLDOUT FRAME 2



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Figure 2-1. Fractional Watt Vuilleumier
Cryogenic Refrigerator

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For analytical purposes, various parts groupings were considered separately. Physical descriptions of these groups are given below.

2. Crankshaft Assembly

The crankshaft assembly is an eccentric shaft on which the cold end crank and the bearing journal are stacked. A bolt threaded into the eccentric shaft secures the parts to the shaft. The hot end crank is an integral part of the shaft.

3. Crankshaft Housing

The group of structural elements surrounding the crankshaft are designated as the crankshaft housing and consist of: the spherical section and flanged crosstubes of the sump housing; the bearing sleeve; the closure cap; the retaining ring; and the inner and outer motor housings. The retaining ring and closure cap form an enclosure on one side of the crankshaft housing, and the inner motor housing form the enclosure on the other side. The ends of the crankshaft housing are connected to the hot and cold end pressure shells by threaded flange connections.

4. Refrigerator Mounting

The refrigerator is mounted by brackets that attach to the sump structure. The brackets support the machine and transmit external environmental loads (i.e., shock and vibration) to the sump mounting points.

5. Hot-End Pressure Shell

The hot-end pressure shell is a cylinder with a flange on one end and a dome at the other. The dome supports the bearing, which supports the hot end of the hot displacer. A vacuum jacket completely surrounds the hot-end pressure shell assembly.

6. Cold-End Pressure Shell

The cold-end pressure shell is a cylinder with a flange on one end and a closure cap on the other end. A vacuum jacket completely surrounds the cold-end pressure shell.

7. Hot-End and Cold End-Displacers

Both displacers are cylindrical in shape, enclosed by domes on the outboard ends. The cylindrical inboard end contain rod bearings for the connecting rods that attach the displacers to the crankshaft. Linear bearings support the reciprocating displacers. The hot-end displacer is supported at both ends. The cold end displacer is supported at the inboard end only.



Stress Analysis Summary

Stress analysis was performed on major sections of the VM refrigerator.. Design load considerations and criteria for material allowable stresses are overviewed below, followed by results of the stress analysis.

1. Loads and Material Stress Criteria

a. Loads

Pressure throughout the enclosure is nearly uniform except for very low pressure differentials (between 6.895×10^3 and 3.447×10^4 N/m² (1 and 5 psi) caused by flow friction. Although the pressure is essentially uniform within the machine, the pressure varies between the approximate limits of 6.088×10^6 N/m² (883 psia) and 6.895×10^6 N/m² (1000 psia) during each crankshaft revolution.

The components subjected to working pressures were analyzed for:

Operating Pressure = 8.62×10^6 N/m² (1250 psia)

Proof Pressure = $1.67 \times$ Operating Pressure =
 1.420×10^7 N/m² (2060 psig)

Burst Pressure = $2.25 \times$ Operating Pressure =
 1.931×10^7 N/m² (2800 psig)

The maximum temperature at the end of the hot end pressure shell is 922°K (1200°F). Temperature at the end of the cold displacer is 65°K (-343°F).

Dynamic loads resulting from the reciprocating motion of the displacers, and environmentally induced vibratory loads were also considered in the stress analysis.

b. Material Stress Criteria

Allowable stresses for various materials used in the refrigerator were generally established as follows:

- o Components subjected to working pressure to withstand proof pressure without permanent deformation and burst pressure without rupture.
- o For components subjected to high temperatures, the allowable creep stress is that value at which 0.2 percent creep occurs in 20,000 hours, (2.28 years).
- o For components subjected to cyclic loads, the allowable stress for steel components will be based on a life requirement of 10^8 cycles.



2. Analytical Summaries

a. Crankshaft Assembly Analysis

Both connecting rods simultaneously transmit three types of loads to the crankshaft: (1) dynamic loads; (2) gas pressure loads; and (3) vibratory loads. Dynamic loads are caused by linear acceleration of displacer masses; the gas pressure load is caused by pressure drop across the regenerative bed; and the vibratory load corresponds to the specified random vibration environment. These combined loads were imposed on the shaft, which was considered as an overhung beam on two supports. Shear and moment diagrams were drawn to identify maximum loads and determine maximum stresses.

A summary of the analysis performed on the crankshaft assembly is presented in Table 2-1.

b. Crankshaft Housing Analysis

The crankshaft housing was analyzed for $8.62 \times 10^6 \text{ N/m}^2$ (1250 psi) maximum operating pressure and $1.931 \times 10^7 \text{ N/m}^2$ (2800 psi) burst pressure. The motor outer housing was analyzed for loads due to random vibration. Portions of the crankshaft housing were included in the hot end pressure shell model and the cold end pressure shell model.

A summary of the analysis performed on the crankshaft housing is presented in Table 2-2.

c. Hot-End Pressure Shell Analysis

The hot end pressure shell was analyzed for $8.62 \times 10^6 \text{ N/m}^2$ (1250 psi) maximum operating pressure and $1.931 \times 10^7 \text{ N/m}^2$ (2800 psi) burst pressure. Stresses due to a vibratory load of 87 g (random vibration) were also determined. In addition, a temperature gradient was imposed on the shell, with 922°K (1200°F) at the dome and 333°K (140°F) at the flange.

A summary of the analysis performed on the hot-end pressure shell is presented in Table 2-3.

d. Cold-End Pressure Shell Analysis

The cold-end pressure shell was analyzed for internal pressure and vibratory loading. The analysis was performed for $2 \times 10^6 \text{ N/m}^2$ (1250 psi) operating pressure and $1.931 \times 10^7 \text{ N/m}^2$ (2800 psi) burst pressure.

A summary of the analysis performed on the cold-end pressure shell is presented in Table 2-4.

e. Hot-End and Cold-End Displacer Analysis

The hot displacer was analyzed for external pressure and temperature loading using Kalnin's shell analysis program. The analysis was performed at maximum



TABLE 2-1

CRANKSHAFT ASSEMBLY STRESS ANALYSIS SUMMARY

Detail Assy/Part	Design Requirement	Comments
Crankshaft stacked-parts, cold crank, bearing journal, and bolt	(a) Stacked-part interfaces must not separate under bending load. (b) Combined axial prestress and bending stresses shall not exceed allowable stress. (c) Shear pins and/or friction between stacked-parts must transmit torque.	Bolt preload sufficient to preclude separation of stacked-parts. Stresses due to preload and vibration less than allowable stresses. Tensile, bending, and thread shear stresses computed. Forces transmitted to crankshaft convert to torque due to crank eccentricity. Shear pins between stacked parts was found sufficient to transmit torque.
Overhang section	Maximum bending and shear stresses must be endured.	Calculated stresses low; margin of safety adequate.
Critical speed analysis	Critical speed must be higher than maximum operating speed.	AiResearch computer program V0245 determined first rigid-body mode to be significantly higher than 400 rpm maximum operating speed.
Crankshaft rotary unbalance	Determine unbalance	Reciprocating linear unbalance was determined as well as rotary unbalance. Results indicated that correction for rotary unbalance not required because: 1) total linear unbalance cannot be corrected; 2) VM is low-speed machine; 3) envelope limitation; 4) past experience with this problem.
Connecting rod, wrist pin and retainer	Parts must endure displacer forces transmitted to crankshaft.	Calculated stresses using displacer forces indicate adequate safety margin.



TABLE 2-2

CRANKSHAFT HOUSING STRESS ANALYSIS SUMMARY

Detail Assy/Part	Design Requirement	Comments
Housing at cross tube intersec- tion	Must withstand maximum pres- sure.	Particular attention given to fact that sump housing is weakened by intersection of the cross tubes. Analysis showed the reinforcement around the holes are adequate to resist the pressures.
Spherical dome and cylinder intersection (cold end)	Must withstand pressure and vibratory loading.	Stresses due to the vibratory loads were added to pressure load stresses and were found to be at safe levels.
Flanged connections	Installation torque must be sufficient to prevent joint separation. Must withstand preload plus applied load.	Installation torque specified on drawing sufficient to pre- vent joint separation. Stresses are low.
Tubular section, cold end	Must withstand pressure and vibratory loading.	Combined stresses are at safe levels.
Motor inner housing	Must withstand internal pres- sure.	Shell analysis and flange analysis show safe stress level.
Motor outer housing	Must withstand vibratory loads.	Analysis of housing and fasteners show acceptable stress levels for 98 g's parallel and 68 g's perpen- dicular to the motor center- line.



TABLE 2-3

HOT-END PRESSURE SHELL STRESS ANALYSIS SUMMARY

Detail Assy/Part	Design Requirement	Comments
Hot-end pressure shell; included hot end flange and adjacent tubular portion of sump housing	Must have adequate strength to support pressure, temperature, and vibratory loading.	Hot end flange and adjacent tubular portion of sump housing were included in the shell analysis model. Analysis was performed with Kalnins' shell program. Pressure and temperature loads were imposed on the shell. Resulting meridional stresses were added to stresses from vibratory loading. Pressure shell strength was found to be adequate to support pressure, temperature, and vibratory loading.
Flanged connection	Installation torque must be sufficient to prevent joint separation. Must withstand preload plus applied load.	Installation torque specified on drawing sufficient to prevent joint separation. Stresses are low.
Shell/displacer deflections	Must be no interference between the shell and displacer under vibratory loading.	Deflections were calculated to determine if interference between the displacer and the heat exchanger sleeve would occur. The computer deflections were found to be less than the clearances.
Hot bearing shaft	Must withstand vibratory loads transmitted to dome, in combination with temperature/pressure loads.	Maximum bending moment at root of hot bearing shaft is transmitted to the dome, generating meridional and hoop stresses. These stresses were manually calculated and added to pressure and temperature stresses. The combined stress did not exceed the allowable stress.
Hot end	Vacuum jacket must be capable of resisting collapsing pressure	Calculations show that collapsing pressure is much higher than actual external pressure.



TABLE 2-4

COLD-END PRESSURE SHELL STRESS ANALYSIS SUMMARY

Detail Assy/Part	Design Requirement	Comments
Pressure shell	Must have adequate strength to withstand pressure, temperature, and vibratory loading.	Pressure shell analyzed with Kalnins' shell program for internal pressure and temperature loading. The temperature was 333°K (140°F) at the sump and 65°K (-343°F) at the cold end. Stresses due to vibratory loads were computed and combined with shell stresses due to max operating pressure. Computed stresses were below the allowable stresses.
Flanged connection	Installation torque must be sufficient to prevent joint separation. Must withstand preload plus applied load.	Installation torque specified to prevent joint separation. Stresses are low.
Cold-end pressure shell and displacer	Determine whether clearance is sufficient to preclude contact between the shell and displacer under vibratory loads. Cold end displacement due to self-induced vibration must not exceed 0.000200 inches.	Analysis indicates contact will occur between the shell and displacer during the application of the vibratory loads. Such contact, however, is not detrimental because: 1) the deflections are elastic and momentary, and 2) the probable consequence of shell/displacer contact would be a momentary stalling of the engine, after which the engine will continue to operate without performance degradation. AiResearch computer program V0245 was used to determine the displacement at the cold end due to self-induced vibration. At max operating speed (400 rpm), displacement at cold end was found to be less than the allowable displacement.
Vacuum jacket	Must be capable of resisting external pressure.	Analysis indicates that vacuum jacket will withstand external pressure with adequate margin of safety.



operating pressure and at burst pressure. The temperature gradient was 922°K (1200°F) at the hot end and 333°K (140°F) at the inboard bearing. The external collapsing pressure were also determined. A summary of the analysis in the hot-end and cold-end displacers is presented in Table 2-5.

TABLE 2-5

HOT END AND COLD END DISPLACER STRESS ANALYSIS SUMMARY

Detail Assy/Part	Design Requirement	Comments
Displacer	Must endure collapsing pressure Must endure combined pressure and temperature loads	Calculated collapsing pressure was found to be much higher than the actual external operating pressure. Hot displacer was analyzed with Kalnins' shell program. A model of the entire displacer and part of the bearing journal section was prepared. Pressure and temperature loads were imposed on the model. Maximum stresses from computer output were less than the allowable stresses. Cold displacer stresses, computed manually, are less than the allowable stresses.
Hot displacer bearing journal	Tip deflection must not cause interference under vibratory loading.	Maximum deflection at the tip was calculated to determine if interference would occur between the journal and the bearing under vibratory loads. The calculated radial displacements were found to be less than the minimum running clearance.



SECTION 3
DESIGN REQUIREMENTS

SECTION 3

DESIGN REQUIREMENTS

INTRODUCTION

The Vuilleumier cryogenic refrigerator has been designed to meet requirements specified by NASA Goddard Space Flight Center (GSFC). This section summarizes NASA GSFC design requirements that served as a basis for the original VM layout drawings.

NASA GSFC PRELIMINARY DESIGN REQUIREMENTS

The NASA GSFC preliminary design requirements are summarized in Table 3-1. These include operational performance requirements and the qualification and operational environments that the machine must endure.

STRESS ANALYSIS

The stress analysis and thermal analysis were based on the layout drawing (Figure 2-1). As a result of these analyses and subsequent design iterations, the drawing was changed to update the basic design.

The vibration requirements for the fractional watt VM refrigerator are given in the following figures:

Figure 3-1. Sinusoidal Vibration in Lateral Direction

Figure 3-2. Sinusoidal Vibration in Longitudinal Direction

Figure 3-3. Random Vibration for Each Axis.



TABLE 3-1
PRELIMINARY DESIGN REQUIREMENTS
VUILLEUMIER CRYOGENIC ENGINE

<u>Parameter</u>	<u>Requirements</u>
<u>Performance</u>	
Cooling capacity at 65 ⁰ K after 2 yrs	1/4 watt min.
Thermal power input	80 watts max.
Electrical power for drive motor	10 watts max.
Temperatures	
Thermal power input	Not specified
Heat rejection	180 ⁰ F
<u>Weight</u>	18 lbs. max.
<u>Size</u>	Not specified
<u>Spacecraft Qualification Environment</u>	
Shock	Not Specified
Humidity	
Temperature	30 ±2 ⁰ C
Relative humidity	90 ±3%
Vibration	
Sinusoidal	
Lateral (X-X and Y-Y)	See Figure 3-1
Longitudinal (Z-Z)	See Figure 3-2
Random	See Figure 3-3
Prelaunch environment	
Temperature	75 ±5 ⁰ F
Relative humidity	50% max.
Duration	3 weeks
Design load	
Ultimate static load factor	30 g
Storage temperature (up to 3 yrs)	0 to 130 ⁰ F
Pressure (up to 3 yrs.)	1 atm to 10 ⁻¹⁰ torr
<u>Operating Environment</u>	
Shock	Not specified
Acceleration	
Level	5 g
Duration	Not specified
Vibration	
Sinusoidal	
Lateral (X-X and Y-Y)	See Figure 3-1
Longitudinal (Z-Z)	See Figure 3-2
Random	See Figure 3-3
Temperature	0 to 120 ⁰ F
Pressure	1 atm to 10 ⁻¹⁰ torr



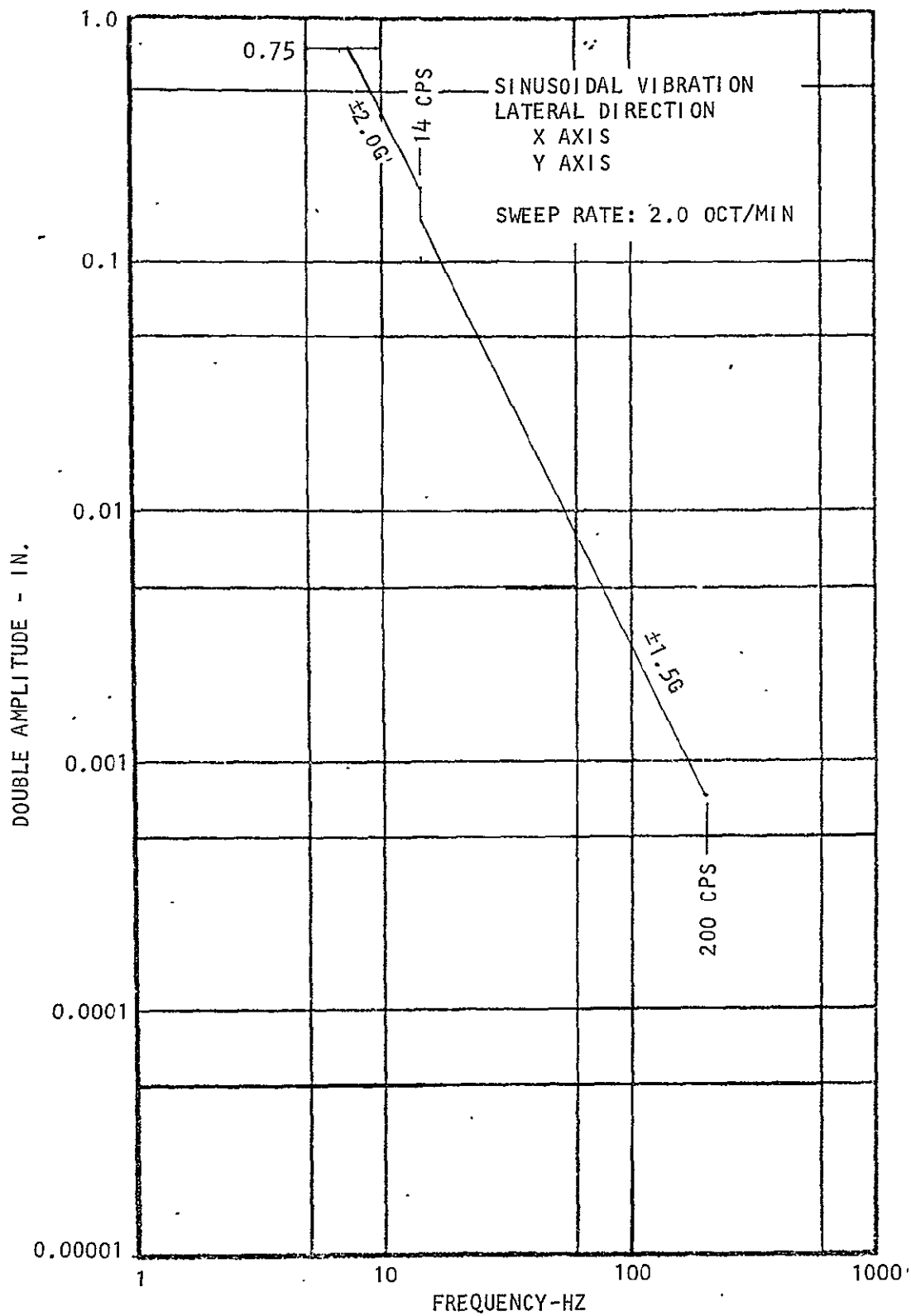


Figure 3-1. Sinusoidal Vibration in Lateral Direction



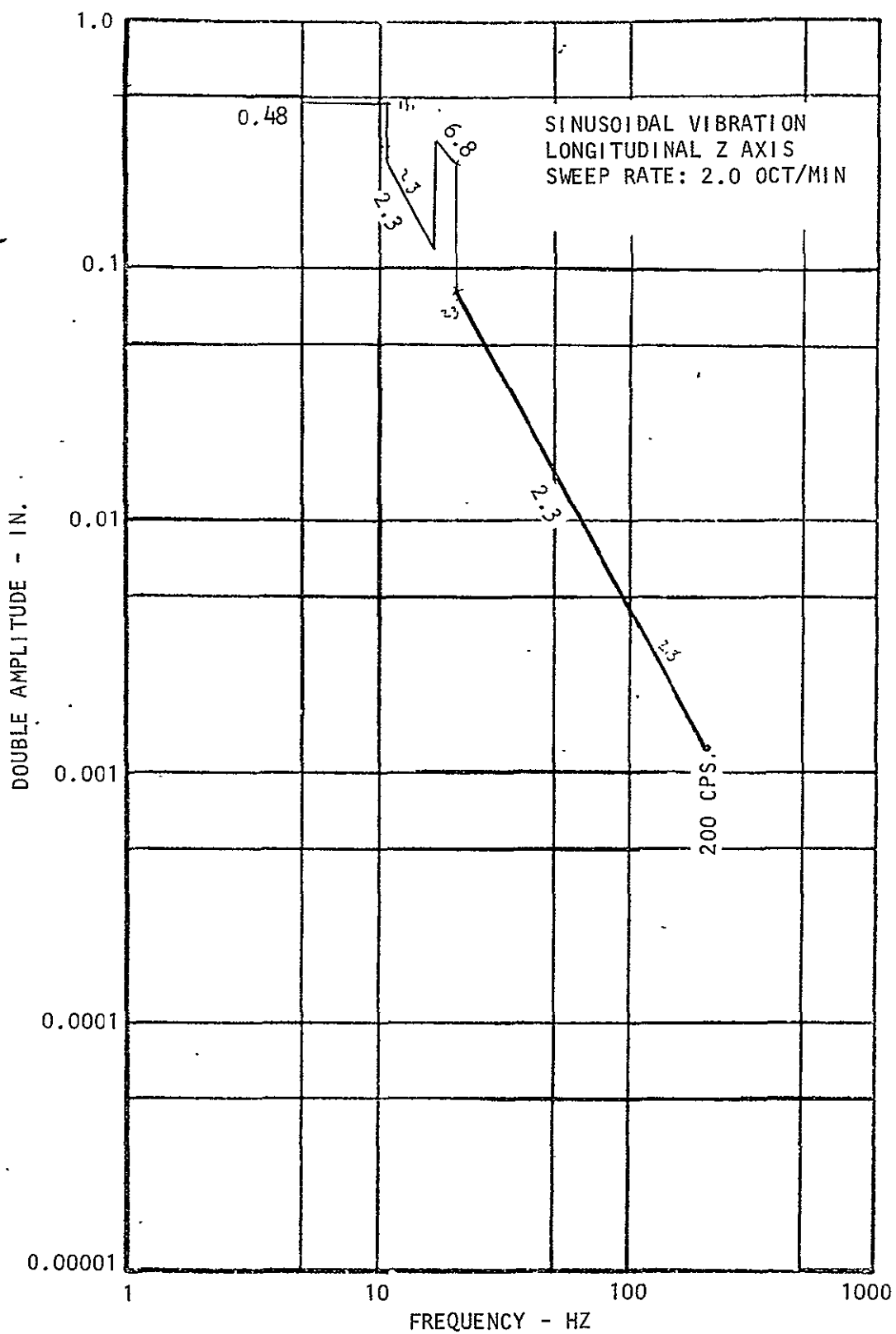


Figure 3-2. Sinusoidal Vibration in the Longitudinal Direction



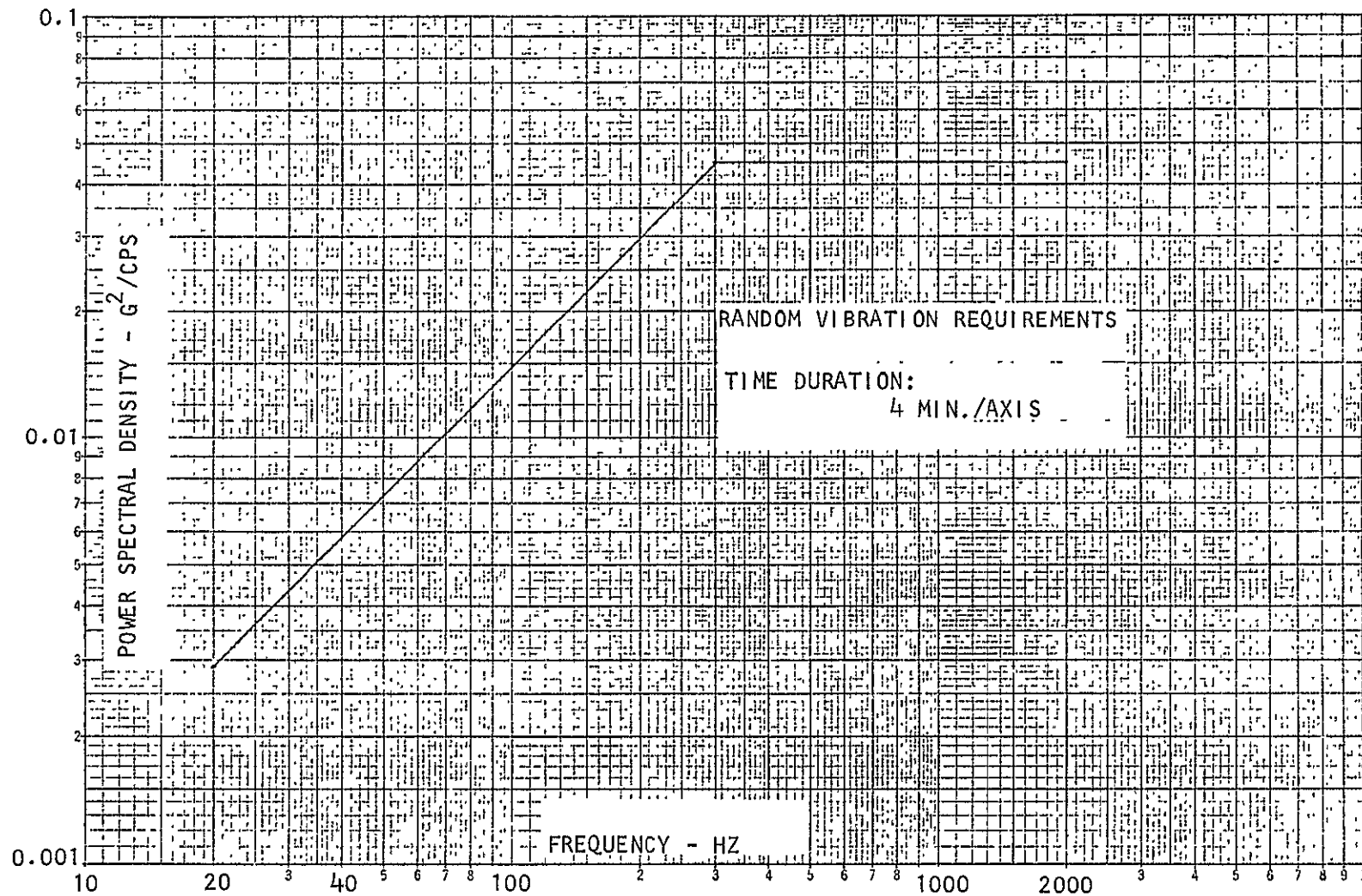


Figure 3-3. Random Vibration Requirements for Each Axis

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SECTION 4
MATERIAL PROPERTIES

SECTION 4

MATERIAL PROPERTIES

This section references/reproduces material properties information that was used during stress analysis performed on the NASA Goddard 1/4 watt Vuilleumier cryogenic refrigerator. Certain material properties catalog information was copyrighted and will not be reproduced here. In this case, the publication and its source are listed.



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CALC. NO. C 6263 SHEET NO. 4-2
MODEL NO. 1/4 W. V.M.
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4. MATERIAL PROPERTIES

- 4.1 INCONEL 718
- 4.2 PH 13-8 Mo
- 4.3 7075 ALUM ALLOY
- 4.4 TITANIUM ALLOY Ti-6Al-4V
- 4.5 TUNGSTEN-CARBINE, CA 310



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4.1 INCONEL 718

The specifications pertaining to Inconel 718 which were used during the stress analysis are listed below.

Aerospace Material Specifications (by Society of Automotive Engineers)

AMS5662B	Alloy Bars, Forgings, and Rings, Corrosion and Heat Resistant
Issued 9-1-65	
Rev. 11-1-67	

AMS5663B	Alloy Bars, Forgings, and Rings, Corrosion and Heat Resistant
Issued 9-1-65	
Rev. 11-1-67	

AMS5596C	Alloy Sheet, Strip, and Plate, Corrosion and Heat Resistant
Issued 1-31-64	
Rev. 11-1-68	

Other Specifications

Catalog T-39	Huntington Alloy Products Division; Inconel 718
International	Catalog T-39, pages 13, 14, 15, and 16
Nickel Corp.	



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4.1 MECHANICAL AND PHYSICAL PROPERTIES OF INCONEL 718

Alloy: Inconel 718, AMS 5662, AMS 5663, AMS 5596

Form: Bars, Forgings, Sheet and Plate;
Consumable Electrode or Vacuum Induction Melted

Condition: Solution and Precipitation Heat Treated

Mechanical Properties at Room Temperature (Minimum):

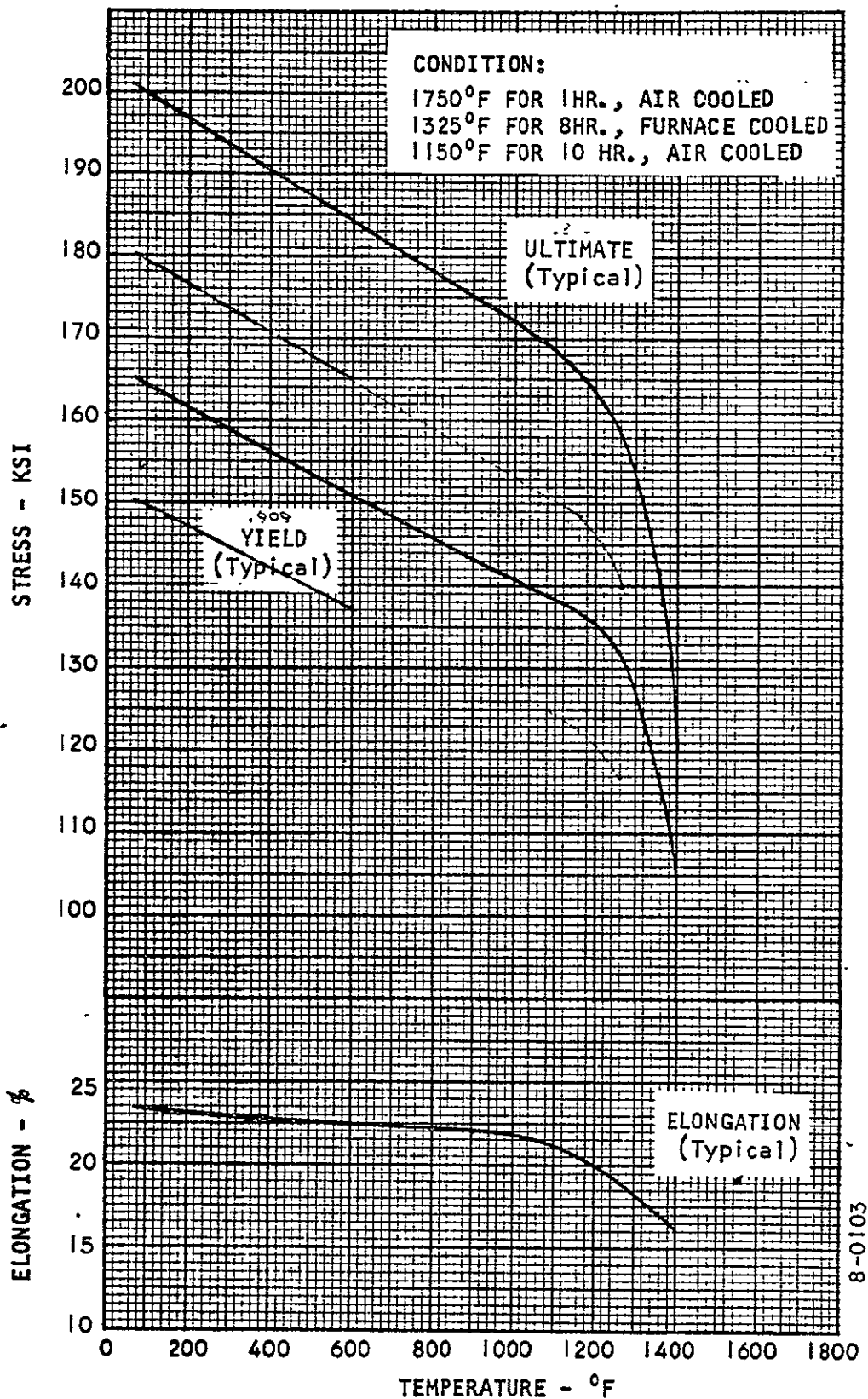
Ultimate Tensile Strength, KSI	180.0
Yield Strength (0.2% offset), KSI	150.0
Elongation, %	10.0

Physical Properties:

Modulus of Elasticity, 10^6 psi	29.6
Density, lb/cu. in.	.297
Thermal Conductivity, BTU/hr/ft ² /°F/ft	6.3 at 70°F
Mean Coefficient of Expansion, 10^{-6} in/in/°F	7.6 (70° to 400°F)

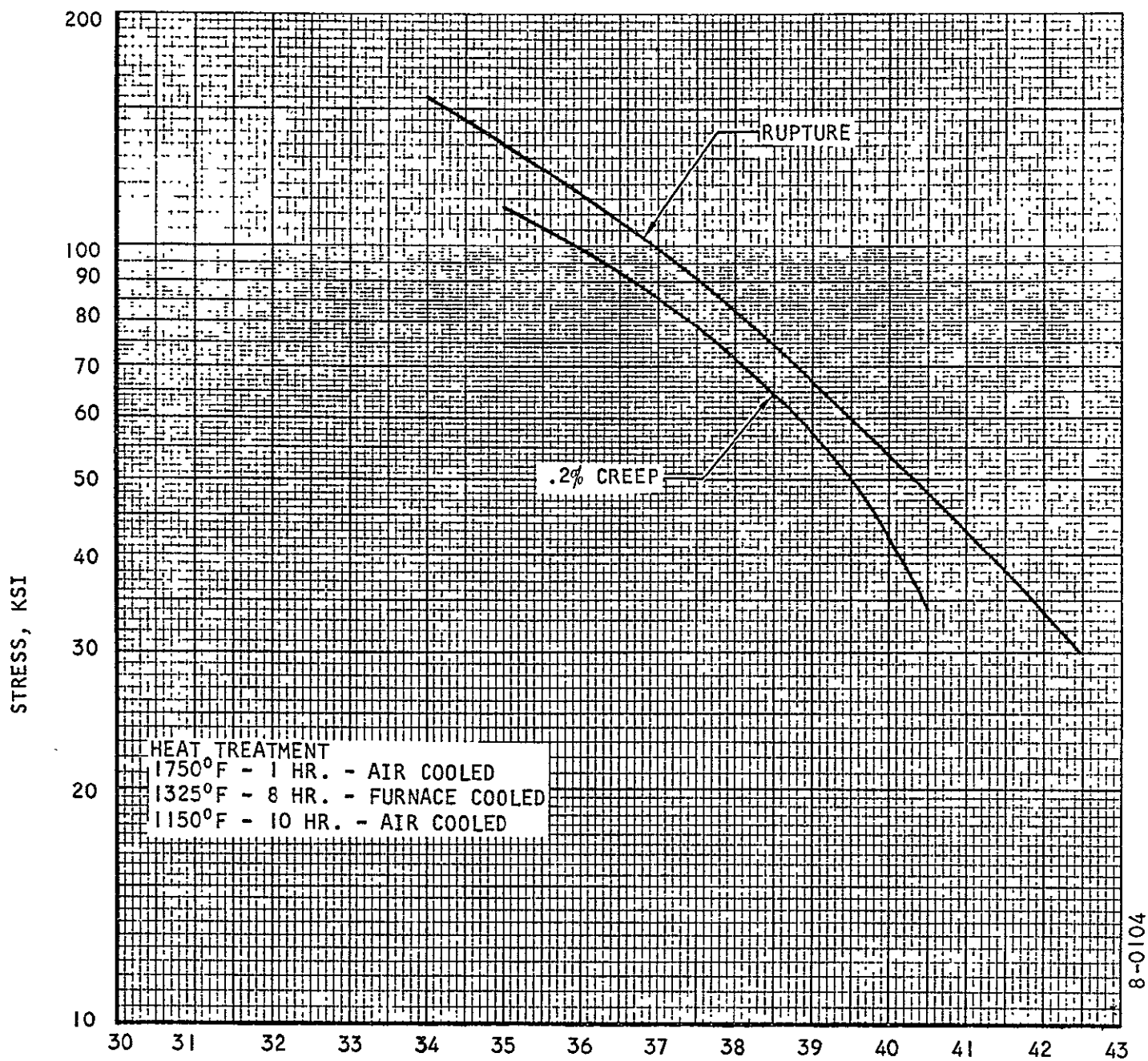


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EFFECT OF TEMPERATURE ON TENSILE PROPERTIES OF INCONEL 718 BAR





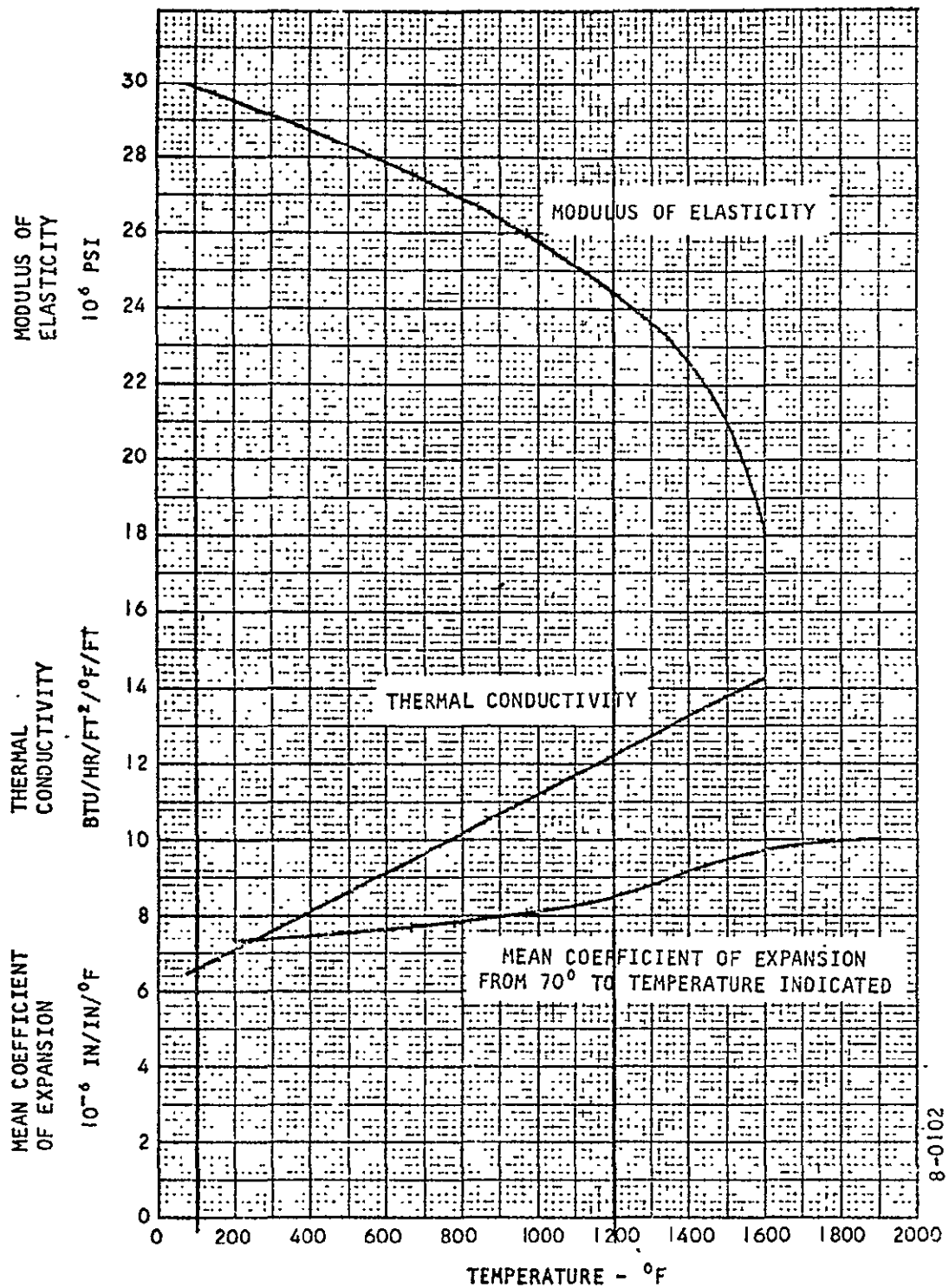
LARSON - MILLER PARAMETER
 $(T + 460)(20 + \log_{10} t) \times 10^{-3}$

WHERE T = TEMPERATURE, °F
 t = TIME, HOURS

TYPICAL STRESS-RUPTURE CURVE
 FOR INCONEL 718



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TYPICAL PHYSICAL PROPERTIES OF INCONEL 718



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MODEL NO. 1/4 W.V.M.
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4.1 INCONEL 718

CREEP AND CREEP RUPTURE VS. TEMPERATURE

LM = LARSON-MILLER PARAMETER

$$= (T + 460)(20 + \log_0 t) \times 10^{-3}$$

WHERE: T = TEMP., °F

t = TIME, HRS.

SEE PAGE 4-6 FOR CREEP AND CREEP-RUPTURE VS. LM

FOR t = 20,000. HRS,

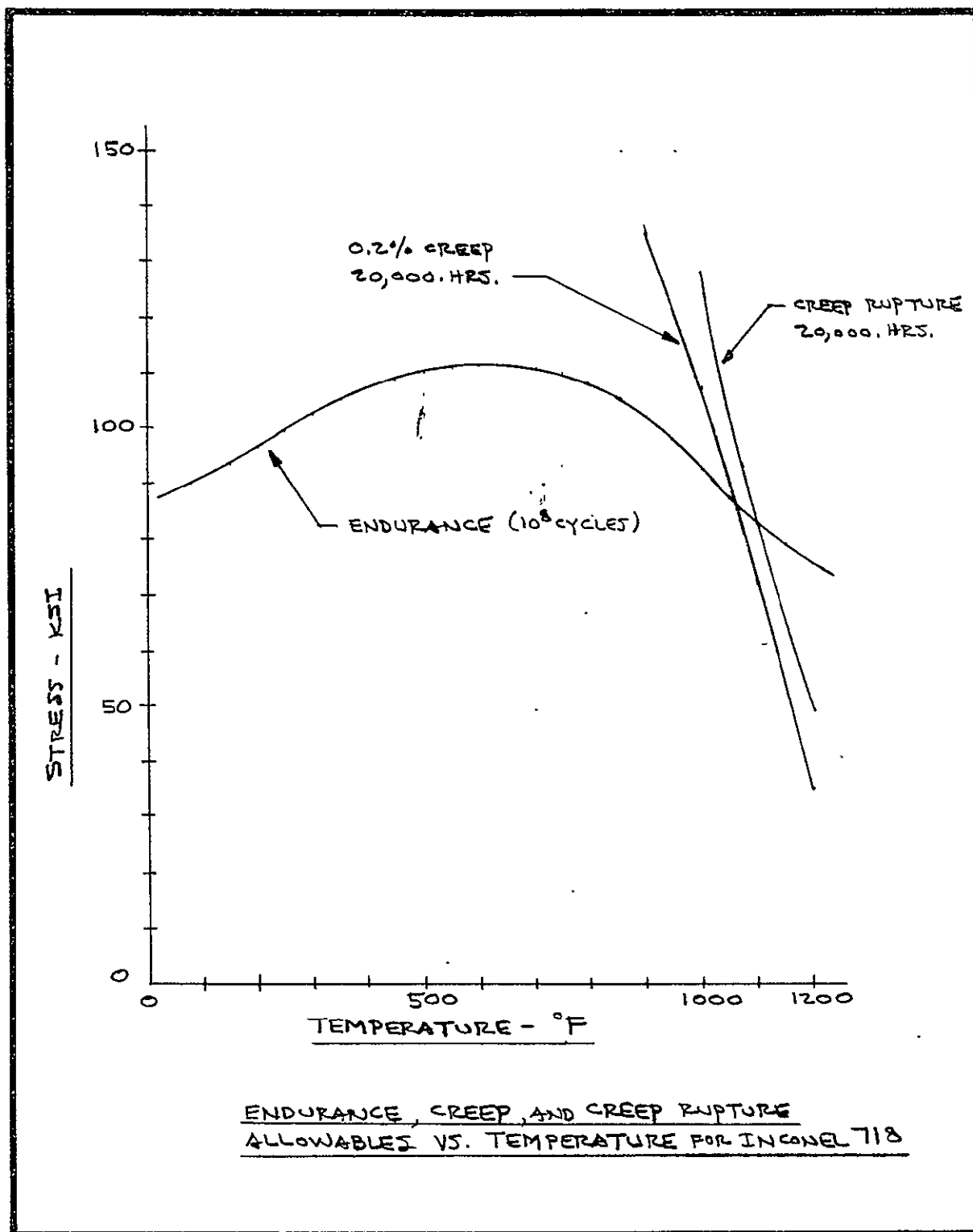
T (°F)	LM	.2% CREEP (KSI)	CREEP-RUPTURE (KSI)
1200.	40.4	35.0	49.0
1100.	38.0	72.0	82.0
1000.	35.4	107.	128.
900.	33.0	135.	—



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CALC. NO. C6263 SHEET NO. 4-10
MODEL NO. 1/4 W.V.M.
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4.2 PH 13-8 Mo

The specification sheets pertaining to ARMCO PH13-8MO used during the stress analysis are listed below:

Catalog S-33b
Product Data
Armco Steel Corp.

Armco PH13-8MO, Precipitation-Hardening
Stainless Steel Bar, Wire, Plate, and Forging
Billets, Pages 4, 6, and 12

FROM MIL-HDBK-5, PH 13-8 Mo IN CONDITION H 1000 HAVE:

$$F_{tu} = 205,000. \text{ PSI}$$

$$F_{ty} = 197,000. \text{ PSI}$$

THE ANALYSIS WILL USE:

$$F_{tu} = \underline{205,000. \text{ PSI}}$$

$$F_{ty} = \underline{190,000. \text{ PSI}}$$



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GOODMAN DIAGRAM

PH-13-8 M₀

CONDITION H-1000

$F_{10} = 200,000$ psi

$F_{-1} = 190,000$ psi

REF: ARMCO PH-13-8 M₀ "PRECIPITATION-HARDENING STAINLESS STEEL
BAR, WELD, RING AND FORGING
BILLETS", PRODUCT DATA S-328

ALTERNATING STRESS - KSI

CYCLES

10^5
 10^6
 10^7

AVERAGE STRESS - KSI



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4.3 7075 ALUM. ALLOY

7075-T73 PER QQ-A-250/12

FROM MIL-HDBK-5,

$$F_{tu} = \underline{67,000. \text{ PSI}}$$

$$F_{ty} = \underline{56,000. \text{ PSI}}$$

STRESS CORROSION "THRESHOLD" STRESS = 43,000. PSI (MIN.)
(SHORT TRANSVERSE)



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4.4 TITANIUM ALLOY Ti-6Al-4V

MECHANICAL AND PHYSICAL PROPERTIES OF TITANIUM ALLOY Ti-6Al-4V

Alloy: Ti-6Al-4V, AMS 4928
Form: Bars and Forgings
Condition: Annealed

Mechanical Properties at Room Temperature:

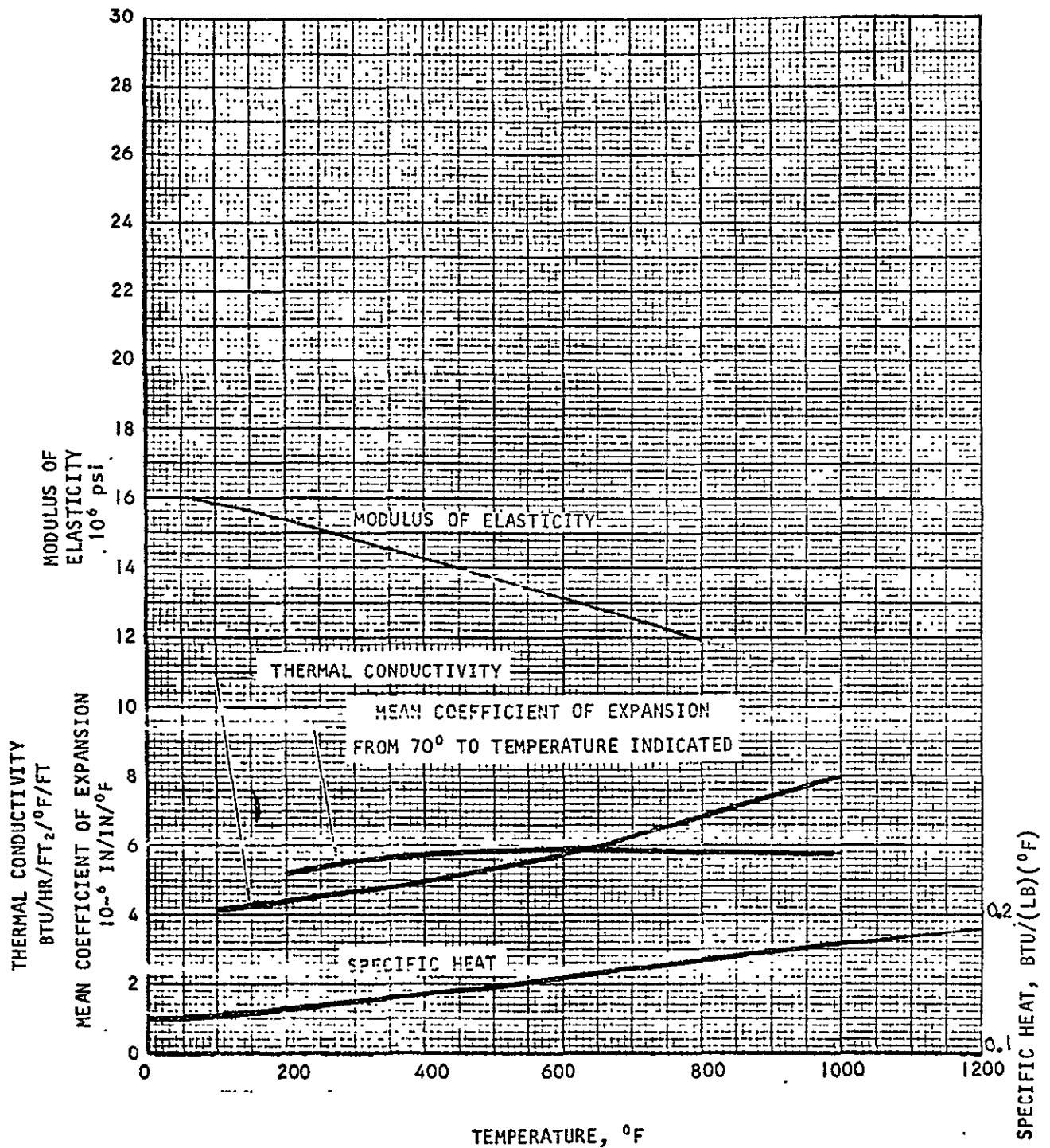
Ultimate Tensile Strength, KSI	130.0 minimum
Yield Strength (0.2% offset), KSI	120.0 minimum
Elongation, % in 4D	10.0 minimum

Physical Properties:

Modulus of Elasticity, 10^6 psi	16.0
Density, lb/cu.in.	0.160
Thermal Conductivity, BTU/hr/ft ² /°F/ft	4.2 at 70°F
Mean Coefficient of Expansion, 10^{-6} in/in/°F	5.3 (70° to 200°F)
Specific Heat, BTU/lb/°F	0.130 at 70°F



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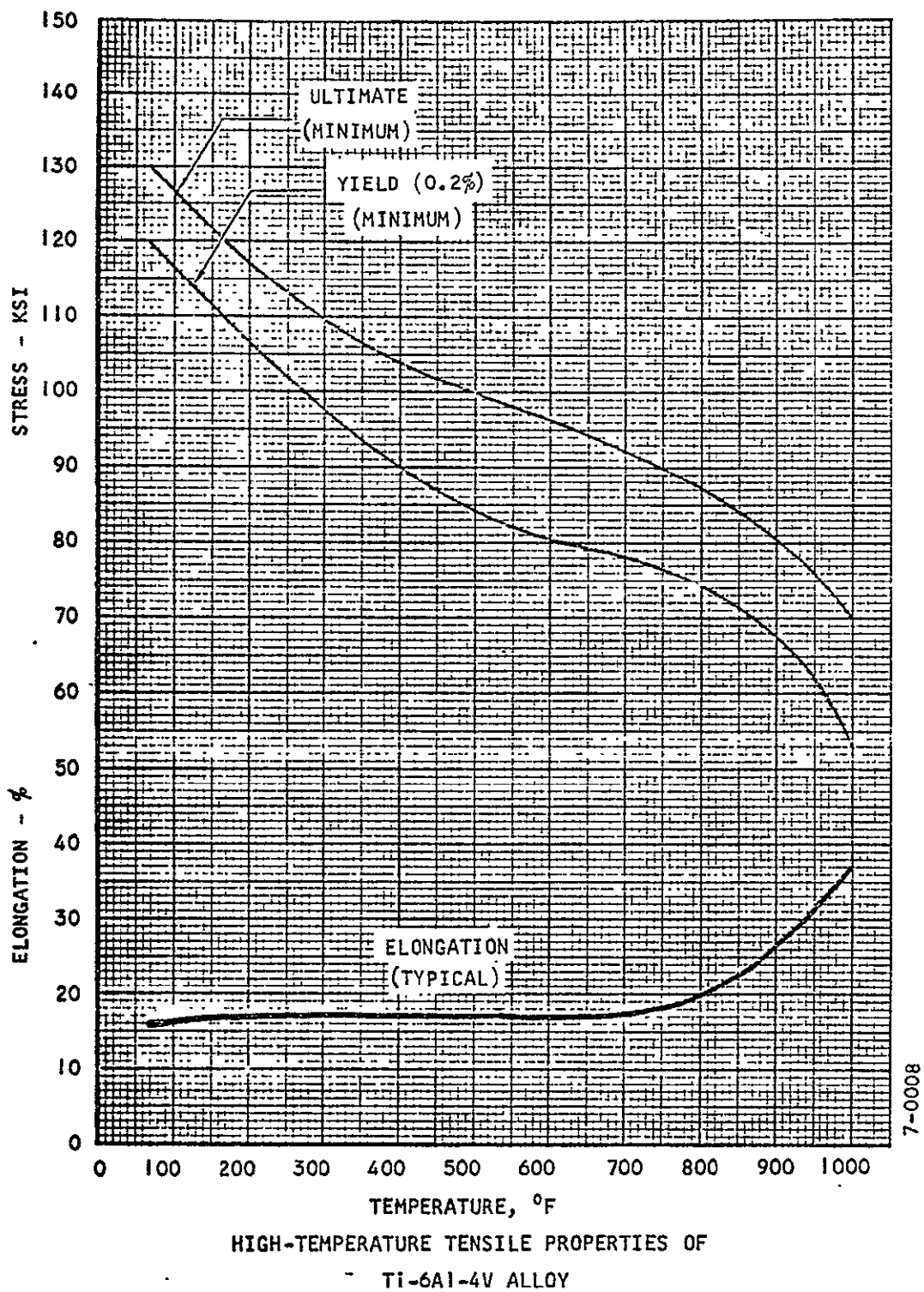


TYPICAL PHYSICAL PROPERTIES OF Ti-6Al-4V

7-0001



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4.5 TUNGSTEN-CARBIDE, CA310

The specification sheets pertaining to tungsten carbide used during the stress analysis are listed below:

Catalog 300 Series
Copyright 1969
Carmet Co.

High Strength Microcarbides for Tools and Dies,
4-page specification

DENSITY: 14.6 gm/cc

TRANSVERSE RUPTURE STRENGTH: 450000 PSI

HARDNESS: 92 Rc

INFORMATION RECEIVED FROM:

CARMET CO. STANTON, CALIF.

PHONE: AC 714 - 828-5820

MR. LARRY WILCASTER INFORMED THAT THE SHEAR
STRENGTH OF THIS MATERIAL IS NEARLY EQUAL TO
ITS TRANSVERSE RUPTURE STRENGTH.

$T_{ULT} \approx 450000 \text{ PSI}$

$T_{ME} = \frac{T_{ULT}}{2.5} = 180000 \text{ PSI}$



SECTION 5
CRANKSHAFT ASSEMBLY STRESS ANALYSIS

DATE 15 JAN 74

PART NO. 852566

PREPARED BY MOTOMOTO

CALC. NO. 66263 SHEET NO. 5-1

MODEL NO. 1/4 W. V.M.

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5. CRANKSHAFT ASSY.

5.1 TASKS

5.2 CRITICAL SPEED ANALYSIS

5.3 SHAFT ANALYSIS

5.3.1 VIBRATORY LOADS

5.3.2 PRESSURE LOADS

5.3.3 DYNAMIC (SELF-INDUCED) LOADS

5.3.4 COMBINED LOADS

5.3.5 STRESS ANALYSIS

5.3.6 BOLT PRELOAD

5.3.7 SHEAR PINS

5.4 CONNECTING ROD, HOT DISPLACER

5.5 CONNECTING ROD, COLD DISPLACER



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CALC. NO. C-6263 SHEET NO. 5-2
MODEL NO. 1/4 W. V.M.
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5.1 TASKS

THE CRANKSHAFT ASSY ANALYSIS CONSISTS OF THE FOLLOWING TASKS:

- DETERMINE SHAFT CRITICAL SPEED
- DETERMINE SINUSOIDAL AND RANDOM VIBRATORY LOADS, PRESSURE LOADS, AND DYNAMIC (SELF INDUCED) LOADS, AND COMBINE AS APPLICABLE.
- PERFORM STRESS ANALYSIS OF SHAFT AND CONNECTED COMPONENTS
- DETERMINE CRANKSHAFT BOLT AXIAL PRELOAD AND TORQUE REQUIRED.



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PREPARED BY MSTH115T0

CALC. NO. 06263 SHEET NO. 5-3
MODEL NO. 14-M.V.M.
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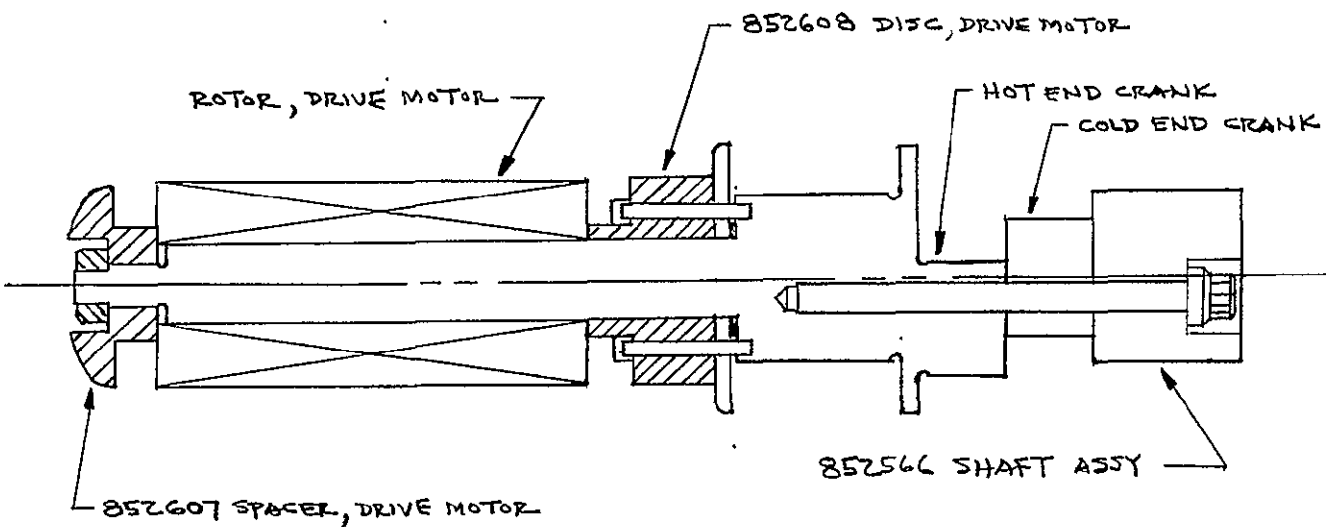


FIG. 5-1 CRANKSHAFT ASSY.



AIRCRAFT RESEARCH MANUFACTURING COMPANY
OF CALIFORNIA

DATE 15 JAN 74
PART NO. 852526
PREPARED BY MOTOMOTO

CALC. NO. C 6263 SHEET NO. 5-4
MODEL NO. 1/4 W.V.M.
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5.2 CRITICAL SPEED ANALYSIS

THE CRITICAL SPEED WAS DETERMINED BY USING AIRESEARCH COMPUTER PROGRAM V0245.

THE MASS MODEL AND STIFFNESS MODEL USED ARE SHOWN IN FIGURES 5-2 AND 5-3.

THE FIRST MODE (CRITICAL) FREQUENCY WAS FOUND TO BE 3770 RPM (62.8 CPS).

COMPARED TO THE 480 RPM MAX OPERATING SPEED, THE CRANKSHAFT CRITICAL SPEED IS SATISFACTORY.



DATE 14 Jan 74

PART NO. 852566

PREPARED BY MSP111570

CALC. NO. 06263 SHEET NO. 5-5

MODEL NO. 1/4 in. V.M.

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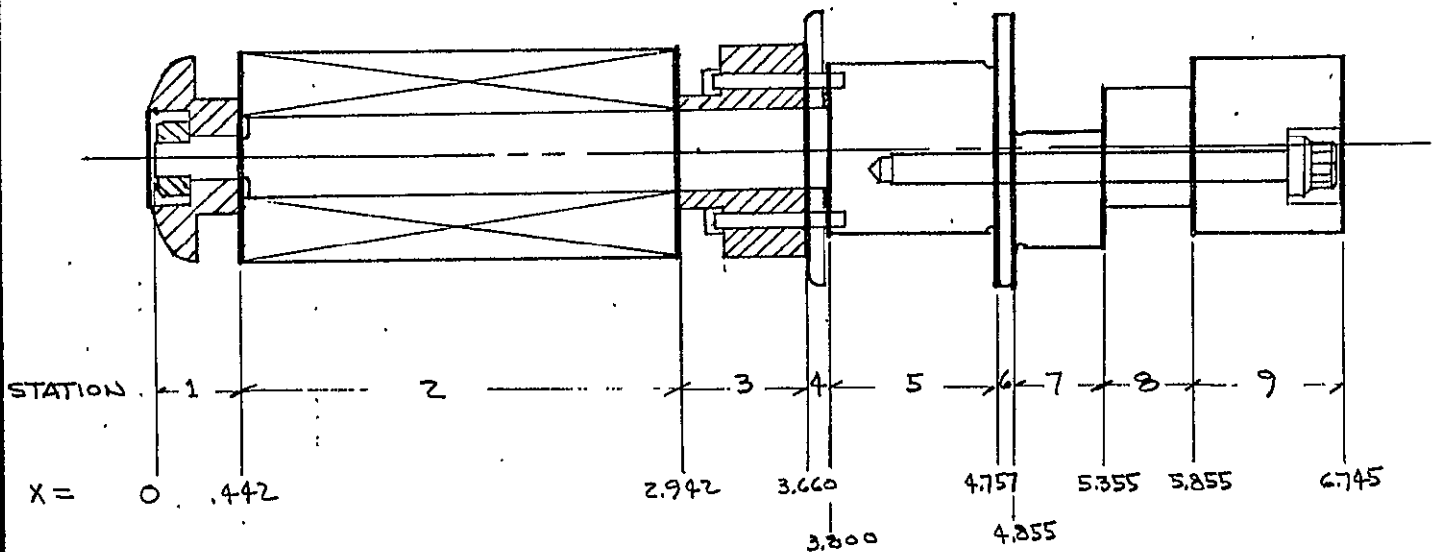


FIG. 5-2 CRANKSHAFT MASS STATIONS
FOR CRITICAL SPEED ANALYSIS



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PART NO. 852566
PREPARED BY MORF1195T0

CALC. NO. 06263 SHEET NO. 5-6
MODEL NO. 1/4 W. V. M.
CHECKED BY _____

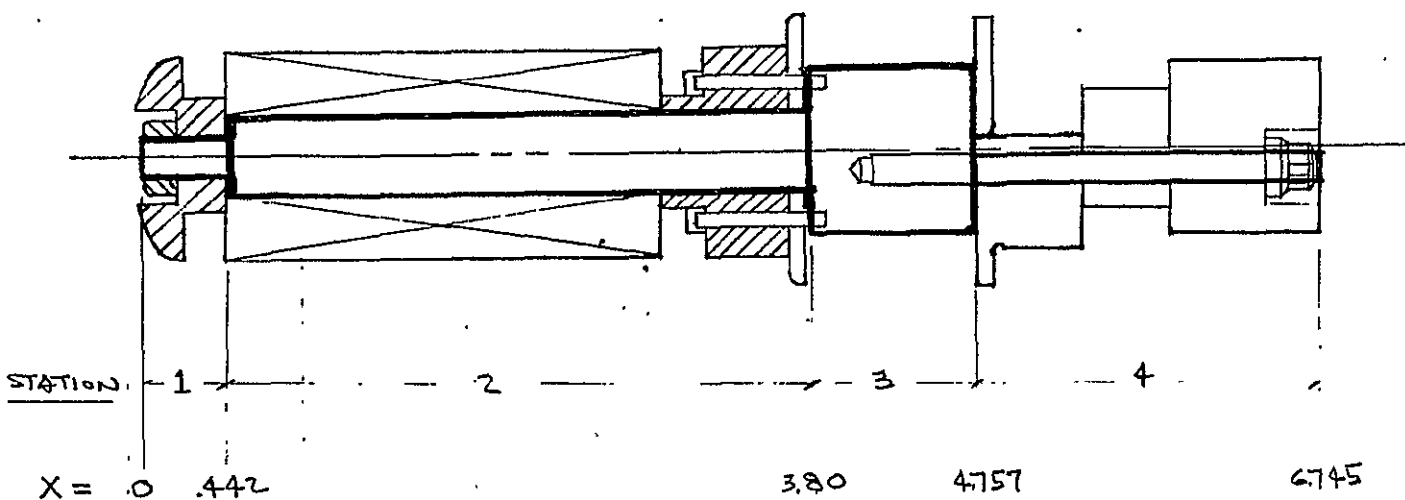


FIG 5-3 CRANKSHAFT STIFFNESS STATIONS
FOR CRITICAL SPEED ANALYSIS



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PREPARED BY MGM/AST

CALC. NO. C6263 SHEET NO. 5-7
MODEL NO. 1/4 W.V.M.
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5.2 CRANKSHAFT CRITICAL SPEED

UNBALANCE AT HOT END CRANK

$$W_H = W_1 + W_2^B + \frac{1}{2} [W_3 + W_2^D]$$

W_H = UNBALANCE AT CRANK RADIUS.

W_1 = WT. OF CRANK & BRG. (852556)

W_2 = WT. OF CONNECTING ROD (852569)

W_2^B, W_2^D = WT. OF CONNECTING ROD "DUMB-BELLED" AT CRANK
BRG. (B) AND Wrist PIN (D), RESPECTIVELY.

W_3 = WT. OF DISPLACER, WRIST PIN RETAINER, WRIST PIN, WRIST
PIN BRG.

$$W_1 = \pi (33.8^*) (.50) (.297) + .14^* = 0.193 \text{ LBS.}$$

$$W_2 = 0.04^* \text{ LBS.}$$

$$W_3 = 1.12^* + .07^* + .02^* + .01^* = 1.22 \text{ LBS.}$$

$$\text{ASSUME } W_2^B = W_2^D = .02$$

$$W_H = .193 + .02 + \frac{1}{2} (1.22 + .02) = \underline{\underline{0.833 \text{ LBS.}}}$$

$$r = .24$$

$$F_{UH} = .833 \times .24 \times 16 = \underline{\underline{3.20 \text{ IN-OZ}}}$$

NOTE: * VALUES FROM WEIGHT REPORT, APPENDIX A.



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PART NO. 252566

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CALC. NO. C6263 SHEET NO. 5-8

MODEL NO. 1/4 W.V.M.

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5.2 CRANKSHAFT CRITICAL SPEED

UNBALANCE AT COLD END CRANK

REFER TO EQUATION AND NOMENCLATURE ON PRECEDING PAGE

$$W_c = W_1 + W_2 + \frac{1}{2} (W_3 + W_2^D)$$

$$W_1 = \pi (3.38) (.50) (.297) + .14 = \underline{0.193 \text{ LBS}}$$

$$W_2 = \underline{0.04 \text{ LBS}}$$

$$W_3 = 0.16 + .05 + .02 + .01 = \underline{0.24 \text{ LBS}}$$

$$\text{ASSUME } W_2^D = W_2 = \underline{0.02 \text{ LBS}}$$

$$W_c = 0.193 + .02 + \frac{1}{2} (0.24 + .02) = \underline{0.343 \text{ LBS}}$$

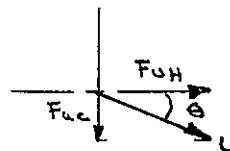
$$r = .22$$

$$F_{u_c} = .343 \times 16 \times .22 = \underline{1.21 \text{ IN-OZ}}$$

TOTAL UNBALANCE

$$U = F_{u_H} + F_c = \underline{3.42 \text{ IN-OZ}}$$

$$\theta = 20.7^\circ$$



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CALC. NO. C6263 SHEET NO. 5-9
MODEL NO. 1/4 W. V.M.
CHECKED BY _____

5.2 CRANKSHAFT CRITICAL SPEED

INPUT DATA FOR VOZ45

STATION 7

$$X_7 = 4.855 + .25 = 5.105 \text{ IN.}$$

$$M_7 = \frac{W_H}{g} = \frac{.833}{386} = 0.00215803 \text{ LB-SEC}^2/\text{IN.}$$

$$I_{p7} = \frac{W}{g} \frac{r^2}{2} = \frac{\pi (.338^4) (.50) (.297)}{386} \times \frac{(.338^4)}{2} = 7.887 \times 10^{-6} \text{ LB-SEC}^2/\text{IN.}$$

(CRANK ONLY)

$$I_{Dc7} = \frac{W}{386} \times \frac{(3 \times .338^4 + .50^4)}{12} = 6.8202 \times 10^{-6} \text{ LB-SEC}^2/\text{IN.}$$

STATION 8

$$X_8 = 5.355 + .25 = 5.605 \text{ IN.}$$

$$M_8 = .343 / 386 = 0.00088860 \text{ LB-SEC}^2/\text{IN.}$$

$$I_{p8} = I_{p7} = 7.887 \times 10^{-6} \text{ LB-SEC}^2/\text{IN.}$$

$$I_{Dc8} = I_{Dc7} = 6.8202 \times 10^{-6} \text{ LB-SEC}^2/\text{IN.}$$

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PART NO. 852511

PREPARED BY Mortmoto

CALC. NO. C 6263 SHEET NO. 5-10

MODEL NO. 1/4 W. V. 171

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V.M. CYROGENIC ENGINE CRANKSHAFT CRITICAL SPEED ANALYSIS									
MIKE MORTMOTO JAN 74									
STATION	XFG	MASS	IP	IO	F11R	F12R	F21R	F22R	
1	1.7655E-01	1.2323E-04	1.2791E-05	7.8852E-06	0.0	0.0	0.0	0.0	
2	1.6920E-00	2.5044E-03	4.5981E-04	1.5343E-03	3.0470E-05	-2.0367E-04	-3.4342E-05	1.5706E-04	
3	3.3571E-00	2.2728E-04	2.9711E-05	2.2908E-05	9.8827E-06	-1.9756E-05	-1.9756E-05	2.3729E-05	
4	3.7083E-00	1.3950E-04	4.3873E-05	2.2059E-05	-1.2549E-07	-8.7878E-07	-8.7878E-07	5.0046E-06	
5	4.2745E-00	5.7826E-04	7.2283E-05	8.0275E-05	-7.7618E-08	-7.6332E-07	-1.6814E-07	1.6336E-06	
6	4.8060E-00	1.5637E-04	5.1614E-05	2.5932E-05	8.3989E-06	-3.3381E-05	-6.7430E-05	1.9111E-04	
7	5.1050E-00	2.1580E-03	7.8900E-06	6.8200E-06	1.2332E-06	-2.4462E-05	-2.4462E-05	1.6363E-04	
8	5.6050E-00	8.8840E-04	7.8900E-06	4.8200E-06	9.3862E-06	-6.8406E-05	-6.8406E-05	2.7362E-04	
9	6.3000E-00	5.3778E-04	6.7222E-05	6.9109E-05	2.7818E-05	-1.3217E-04	-1.3217E-04	3.8034E-04	
STATION	VR	VI	MR	MI	F11I	F12I	F21I	F22I	
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
STATION	DYR	DYI	OTHER	DTHEI	EYR	EYI	ETHER	ETHEI	
1	0.0	0.0	0.0	0.0	1.0000E-02	0.0	0.0	0.0	
2	0.0	0.0	0.0	0.0	1.0000E-02	0.0	0.0	0.0	
3	0.0	0.0	0.0	0.0	1.0000E-02	0.0	0.0	0.0	
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
7	0.0	0.0	0.0	0.0	2.4000E-01	0.0	0.0	0.0	
8	0.0	0.0	0.0	0.0	2.2000E-01	0.0	0.0	0.0	
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	



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MODEL NO. 1/4 W. V.M.
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V.M. CYROGENIC ENGINE CRANKSHAFT CRITICAL SPEED ANALYSIS
MIKE MORIMOTO JAN 74

VIBX RPMC	VIBX CPS	VIBX RAD/SEC	SYS RPM	AXIAL P	SHAFT/WHIRL RATIO
3765.2	62.75	394.29	0.0	0.0	1.000 1

STATION	APSY	PHASE	THETA	PHASE	SHEAR	PHASE	MOMENT	PHASE
1	7.6352E-01	1.8000E 02	1.8874E-01	1.8000E 02	1.4435E 01	1.8000E 02	1.4394E-01	1.8000E 02
2	4.7790E-01	1.8000E 02	1.8827E-01	1.8000E 02	1.9641E 02	1.8000E 02	5.3181E 01	0.0
3	1.6740E-01	1.8000E 02	1.8312E-01	1.8000E 02	2.0217E 02	1.8000E 02	3.8037E 02	0.0
4	1.0340E-01	1.8000E 02	1.8104E-01	1.8000E 02	2.0442E 02	1.8000E 02	4.5076E 02	0.0
5	5.0481E-04	1.8000E 02	1.8027E-01	1.8000E 02	1.9940E 02	0.0	5.6753E 02	0.0
6	7.7317E-02	0.0	8.5252E-02	1.8000E 02	2.0128E 02	0.0	4.6201E 02	0.0
7	9.1754E-02	0.0	1.4579E-02	1.8000E 02	3.1258E 02	0.0	4.0183E 02	0.0
8	7.4490E-02	0.0	7.3988E-02	0.0	3.5326E 02	0.0	2.4555E 02	0.0
9	4.4162E-04	0.0	1.2069E-01	0.0	3.2739E-08	0.0	3.4557E-10	0.0

STATION	BRGV	PHASE	BRGM	PHASE	AVGP
5	4.0385E 02	1.8000E 02	0.0	0.0	0.0
9	3.5330E 02	0.0	0.0	0.0	0.0

STATION	ZK	PHASE	ZT	PHASE	ZKT	PHASE	ZTK	PHASE
5	8.0000E 05	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	8.0000E 05	0.0	0.0	0.0	0.0	0.0	0.0	0.0



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Page 5-12

V.M. CYROGENIC ENGINE CRANKSHAFT CRITICAL SPEED ANALYSIS									
MIKE MORIMOTO JAN 74									
VIBXRPK		VIBXCPS		VIBXRAD/SEC		SYSRPM		AXIAL P	
34798.8		579.98		3644.12		0.0		0.0	
SHAFT/WHIRL RATIO		1							
1.000									
STATION	ARV	PHASE	THETA	PHASE	SHEAR	PHASE	MOMENT	PHASE	
1	2.5867E 01	1.8000E 02	1.2115E 01	1.8000E 02	4.2312E 04	1.8000E 02	7.8918E 02	1.8000E 02	
2	8.6367E 00	1.8000E 02	1.0785E 01	1.8000E 02	3.2922E 05	1.8000E 02	2.1723E 05	0.0	
3	1.7774E 00	0.0	8.7314E-01	0.0	3.2382E 05	1.8000E 02	7.6549E 05	0.0	
4	8.3869E-01	0.0	4.9887E 00	0.0	3.2227E 05	1.8000E 02	8.8066E 05	0.0	
5	2.6530E 00	1.8000E 02	6.4816E 00	0.0	1.7797E 06	0.0	1.0637E 06	0.0	
6	2.6633E 01	1.8000E 02	8.9763E 01	0.0	1.7244E 06	0.0	1.5552E 05	0.0	
7	5.5149E 01	1.8000E 02	7.3026E 01	0.0	1.5089E 05	0.0	3.5905E 05	1.8000E 02	
8	6.5685E 01	1.8000E 02	3.5540E 01	1.8000E 02	6.2162E 05	1.8000E 02	4.3500E 05	1.8000E 02	
9	7.8402E-01	1.8000E 02	1.1883E 02	1.8000E 02	9.8187E-06	0.0	6.6966E-08	0.0	
STATION	BRGV	PHASE	BRGM	PHASE	AVGP				
5	2.1224E 06	1.8000E 02	0.0	0.0	0.0				
9	6.2721E 05	1.8000E 02	0.0	0.0	0.0				
STATION	ZK	PHASE	ZT	PHASE	ZKT	PHASE	ZTK	PHASE	
5	8.0000E 05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
9	8.0000E 05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
SEARCHING COMPLETED FROM 0.0 TO 6.2832E 03 RAD/SEC									
60,000. Rpm									

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CALC. NO. C6263 SHEET NO. 5-13
MODEL NO. 1/4 W.V.M.
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5.3 SHAFT ANALYSIS

5.3.1 VIBRATORY LOADS

THE SINUSOIDAL VIBRATION SPECTRUM FREQUENCY RANGE IS 5 TO 200 CPS, AND THE RANDOM VIBRATION SPECTRUM FREQUENCY RANGE IS 20 TO 2000, CPS, (REF. SECTION 3)

THE CRITICAL SPEED ANALYSIS YIELDED:

FIRST MODE FREQUENCY, $f_1 = 62.8$ CPS } REF. PG 5-11
SECOND MODE FREQUENCY, $f_2 = 580$ CPS } AND 5-12

THE SINUSOIDAL VIBRATORY LOADING, BASED ON AN ASSUMED MAGNIFICATION FACTOR OF 10, IS:

$$L.F._S = 2.3 \times 10. = 23, \quad (\text{REF. SECTION 3})$$

THE RANDOM VIBRATORY LOADING, BASED ON AN ASSUMED MAGNIFICATION FACTOR OF 10, IS:

$$L.F._R = \left(\frac{\pi}{2} \times \text{PSD} \times T \times f_n \right)^{1/2}$$

AT $f_1 = 62.8$ CPS, PSD = .010 (REF. SECTION 3)

$$\begin{aligned} L.F._{R1} &= 3 \left(\frac{\pi}{2} \times .010 \times 10. \times 62.8 \right)^{1/2} \\ &= \underline{9.42 \text{ G's}} \quad (3 \text{ SIGMA RESPONSE}) \end{aligned}$$

AT $f_2 = 580$ CPS, PSD = .045 (MAX VALUE)

$$\begin{aligned} L.F._{R2} &= 3 \left(\frac{\pi}{2} \times .045 \times 10. \times 580. \right)^{1/2} \\ &= \underline{60.7 \text{ G's}} \quad (3 \text{ SIGMA RESPONSE}) \end{aligned}$$



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CALC. NO. C 6263 SHEET NO. 5-14
MODEL NO. 1/4 W.V.M.
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5.3 SHAFT ANALYSIS

5.3.1 VIBRATORY LOADS

THE LOADING FROM THE RANDOM VIBRATION SPECTRUM AT 520 CPS IS GREATEST.

$$L.F. = 60.7 \text{ G'S}$$

THE LOADS ON THE CRANKSHAFT ARE:

$$P = (\text{WT. OF DISPLACER, WRIST PIN RETAINER, WRIST PIN, WRIST PIN BRG., CONNECTING ROD, CONNECTING ROD BRG. \& CRANK}) \times (\text{LOAD FACTOR})$$

$$P_H = (1.12 + .07 + .02 + .01 + .04 + .14 + .053) \times (60.7) \\ = \underline{88.2 \text{ LBS.}}$$

$$P_C = (0.16 + .05 + .02 + .01 + .04 + .14 + .053) \times (60.7) \\ = \underline{28.7 \text{ LBS.}}$$

5.3.2 PRESSURE LOADS

$$\Delta P_{\text{max}} = 5. \text{ psi (ASSUMED FOR DRAG ONLY)}$$

$$P_H' = \frac{\pi}{4} \times 2.25^2 \times 5. = \underline{20. \text{ LBS.}}$$

$$P_C' = \frac{\pi}{4} \times .40^2 \times 5. = \underline{0.628 \text{ LBS.}}$$



DATE 13 NOV 72
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CALC. NO. C 6263 SHEET NO. 5-15
 MODEL NO. 1/4 W.V.M.
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5.3 SHAFT ANALYSIS

5.3.3 DYNAMIC LOADS

THE SELF-INDUCED DYNAMIC LOADING AT THE CRANKS ARE:

$$P_z = \frac{\omega^2}{g} \left[(W_3 + W_L^D)R + W_L^B R + W_1 D_1 \right] \cos \theta + (W_3 + W_L^D) L \left(\frac{R}{L} \right)^2 \cos 2\theta$$

$$P_x = \frac{\omega^2}{g} \left[W_1 D_1 + W_L^B R \right] \sin \theta$$

WHERE: W_1 = WT. OF CRANK AND BRG.

W_L = WT. OF CONNECTING ROD

W_L^B, W_L^D = WT. OF CONNECTING ROD "DUMB-BELLS" AT CRANK BRG. AND DISPLACER, RESPECTIVELY.

W_3 = WT. OF DISPLACER, WRIST PIN RETAINER, WRIST PIN, WRIST PIN BRG.

R = CRANK RADIUS

D_1 = C.G. OF CRANK.



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CALC. NO. C 6263 SHEET NO. 5-16
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5.3 SHAFT ANALYSIS

5.3.3 DYN. LOADING - HOT DISPLACER

REF. PG. 5-7 FOR WEIGHTS

$$\begin{aligned} W_1 &= .193 \text{ LBS} \\ W_2 &= .04 \text{ LBS} \\ W_2^B = W_2^D &= \frac{1}{2} W_2 = .02 \text{ LBS. (ASSUMED)} \\ W_3 &= 1.22 \text{ LBS.} \\ R &= 0.24 \text{ IN.} \\ D_1 &= 0.24 \text{ IN.} \\ L &= 1.75 \text{ IN.} \\ \omega &= 400 \text{ RPM} = 41.89 \text{ RAD/SEC} \end{aligned}$$

$$W_3 + W_2^D = 1.10$$

$$\begin{aligned} P_z &= \frac{41.89^2}{386} \left[(1.24 \times .24 + .02 \times .24 + .193 \times .24) \cos \theta \right. \\ &\quad \left. + (1.24 \times \frac{.24^2}{1.75}) \cos 2\theta \right] \\ &= \underline{1.58530 \cos \theta + 0.04081 \cos 2\theta} \end{aligned}$$

$$\begin{aligned} P_x &= \frac{41.89^2}{386} (.193 \times .24 + .02 \times .24) \sin \theta \\ &= \underline{0.23239 \sin \theta} \end{aligned}$$

θ	P_z	P_x
0	1.626	0
90	-.041	.232
180	-1.544	0
270	-.041	-.232



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MODEL NO. 1/4 W. V.M.
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5.3 SHAFT ANALYSIS

5.3.4 COMBINED LOADING

THE LOADS DUE TO VIBRATION (RANDOM) AND PRESSURE WILL BE COMBINED. THE DYNAMIC (SELF INDUCED) LOADS WILL BE NEGLECTED; $P_{H\max} = 1.63 \text{ LBS}$ AND $P_{C\max} = 0.507 \text{ LBS}$.

TO DETERMINE THE VIBRATORY LOADS, THE MAX ACCELERATION WILL BE APPLIED TO THE SHAFT AND ATTACHED COMPONENTS.

AIRSEARCH COMPUTER PROGRAM VOZ45 WILL BE USED TO OBTAIN THE SHEAR AND MOMENT ALONG THE CRANKSHAFT. AN ACCELERATION OF 60.7 G's WILL BE APPLIED TO THE MASSES. AT STATIONS 7 AND 8, DISPLACEMENT DYNAMIC LOADS AND PRESSURE LOADS WERE APPLIED ALSO. THE COMPUTER OUTPUT AND SHEAR AND MOMENT DIAGRAMS ARE SHOWN ON THE FOLLOWING PAGES.



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PART NO. 85256C

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CALC. NO. C2763 SHEET NO. 5-19

MODEL NO. 1/4 W. V.M.

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V.M. CRYOGENIC ENGINE CRANKSHAFT ANALYSIS DUE TO RANDOM VIBRATION
PLUS PRESSURE LOADS MIKE MORIMOTO JAN 74

STATION	XCG	MASS	IP	ID	F11R	F12R	F21R	F22R
1	1.7655E-01	1.2323E-04	1.2791E-05	7.8852E-06	0.0	0.0	0.0	0.0
2	1.6920E 00	2.5044E-03	4.5981E-04	1.5343E-03	3.0470E-05	-2.0367E-04	-3.4142E-05	1.5706E-04
3	3.3571E 00	2.2728E-04	2.9711E-05	2.2908E-05	9.8827E-06	-1.9756E-05	-1.9756E-05	2.3729E-05
4	3.7083E 00	1.3950E-04	4.3873E-05	2.2059E-05	-1.2549E-07	-8.7878E-07	-8.7878E-07	5.0046E-06
5	4.2785E 00	5.7826E-04	7.2283E-05	8.0275E-05	-7.7618E-08	-7.6332E-07	-1.6814E-07	1.6336E-06
6	4.8060E 00	1.5637E-04	5.1614E-05	2.5932E-05	8.3989E-06	-3.3381E-05	-6.7430E-05	1.9111E-04
7	5.1050E 00	2.1580E-03	7.8900E-06	6.8200E-06	1.2332E-06	-2.4462E-05	-2.4462E-05	1.6363E-04
8	5.6050E 00	6.8860E-04	7.8900E-06	6.8200E-06	9.3862E-06	-6.8406E-05	-6.8406E-05	2.7362E-04
9	6.3000E 00	5.3778E-04	6.7222E-05	6.9109E-05	2.7818E-05	-1.3217E-04	-1.3217E-04	3.8034E-04

STATION	VR	VI	HR	HI	F11I	F12I	F21I	F22I
1	2.8870E 00	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	5.8679E 01	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	5.3250E 00	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	3.2690E 00	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	1.3549E 01	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	3.6640E 00	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	1.0820E 02	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	2.9300E 01	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	1.2600E 01	0.0	0.0	0.0	0.0	0.0	0.0	0.0

STATION	DYR	DYI	DYER	DYEI	EYR	EYI	ETHER	ETHEI
1	0.0	0.0	0.0	0.0	1.0000E-02	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	1.0000E-02	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	1.0000E-02	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	2.4000E-01	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	2.2000E-01	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

VIBXPHC	VIBXPCSC	VIBXRAD/S	SYSRPM	AXIAL P	SHAFT/WHIRL RATIO				
0.0	0.0	0.0	0.0	0.0	1.000				
STATION	ABSY	PHASE	THETA	SHEAR	MOMENT	ZK	REZK	IMZK	Z
1	1.2740E-01	0.0	3.1661E-02	2.8870E 00	0.0	0.0	0.0	0.0	0.0
2	7.9511E-02	0.0	3.1562E-02	6.1566E 01	4.3751E 00	0.0	0.0	0.0	0.0
3	2.7652E-02	0.0	3.0242E-02	6.6891E 01	1.0689E 02	0.0	0.0	0.0	0.0
4	1.7117E-02	0.0	2.9648E-02	7.0160E 01	1.3038E 02	0.0	0.0	0.0	0.0
5	3.0592E-04	0.0	2.9423E-02	1.6103E 02	1.7039E 02	8.0000E 05	8.0000E 05	0.0	0.0
6	1.0880E-02	1.8000E 02	7.7189E-03	1.5737E 02	8.5442E 01	0.0	0.0	0.0	0.0
7	1.1292E-02	1.8000E 02	2.4122E-03	4.9166E 01	3.8390E 01	0.0	0.0	0.0	0.0
8	7.9208E-03	1.8000E 02	9.5534E-03	1.9866E 01	1.3407E 01	0.0	0.0	0.0	0.0
9	9.0825E-06	1.8000E 02	1.2179E-02	1.5600E-08	4.1780E-11	8.0000E 05	8.0000E 05	0.0	0.0

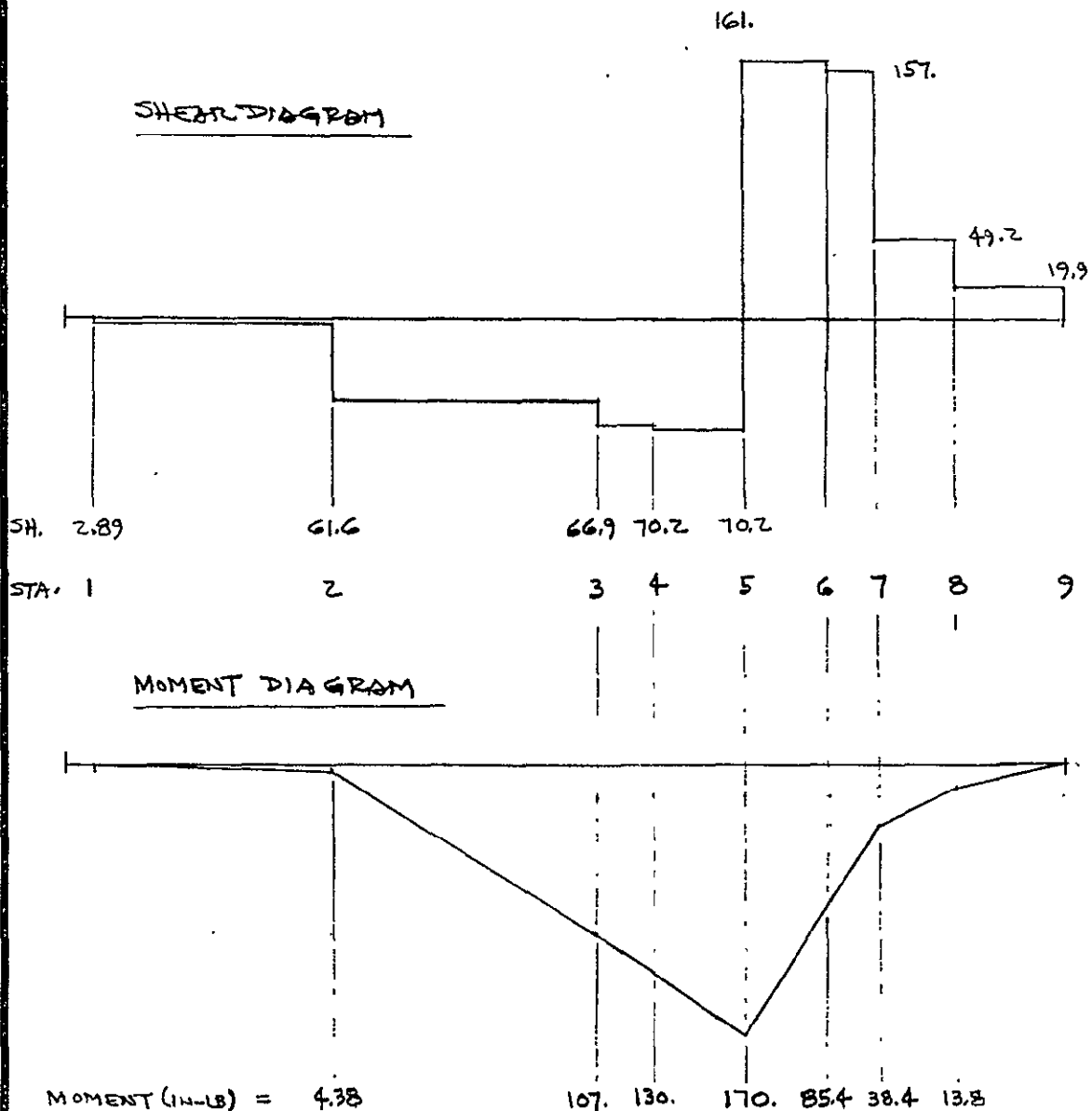
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CALC. NO. C6263 SHEET NO. 5-20
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5.3 SHAFT ANALYSIS

5.3.4 COMBINED LOADS



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5.3 SHAFT ANALYSIS

5.3.5 STRESS ANALYSIS

<u>X (IN.)</u>	<u>M (IN-LB)</u>	<u>R (IN.)</u>	<u>f_b (PSI)</u>
3.800	137.	.234	13,600.
4.279	170.	.500	1,700.
5.355	26.1	.094	40,000.

MAX f_b (40,000. PSI) OCCURS IN THE BOLT

MAT'L IS CRES PH 13-8 Mo CONDITION H 1000.

$$F_{tu} = 205,000. \text{ PSI}$$

$$F_{ty} = 190,000. \text{ PSI}$$

THE BOLT WILL BE TORQUED TO 45 TO 50 IN-LBS.
 $\mu = .05$ TO $.15$ FOR "MILY COATED" SURFACE.

$$P = \frac{T K}{(D_m + D_p)} \quad K = 37.0 \text{ FOR } \mu = .05$$

$$\text{MAX } P = \frac{50 \times 37.}{(.33 + .170)} = 3700. \text{ LBS (T}_{\text{MAX}} \text{ AND MIN. } \mu)$$

$$f_t = \frac{P}{A} = \frac{3700.}{\pi \times .094^2} = 153,000. \text{ PSI (AT } X = 5.355 \text{ IN.)}$$

$$f_b + f_t = 173,000. \text{ PSI}$$

$$M.S. = \frac{190,000.}{173,000.} - 1 =$$

.10



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5.3 SHAFT ANALYSIS

5.3.5 STRESS ANALYSIS

ITEM 1 OF DWG 852567 - CHECK HOOP TENSION DUE TO BOLT THREAD
 LOAD
 - CHECK SHEAR STRESS IN THREAD

MATL: CRES PH 13-8 MO. CONDITION H1000
 $F_{T0} = 205. \text{KSI}$ $F_{Ty} = 190. \text{KSI}$
 $F_{Sy} = 114. \text{KSI}$

HOOP STRESS

$$USE \quad D_o = 2 \left[\frac{.667}{2} - (.111 + .121)^K \right] = .339 \text{ IN.}$$

$$D_M = \text{MAX. MAJOR DIA.} = .197$$

$$D_o/D_M = 1.72 \quad C_n = .56$$

ASSUME $L_D = 1.5$, $N = 1.5 \times .171 \times 32 = 8$. THREADS

MAX P = 3700. LBS (SEE PRECEDING PAGE)

$$S_A = \frac{C_n F_w}{(N+1)(D_o - D_M)}$$

$$= \frac{.56 \times 32 \times 3700.}{9 \times (.339 - .197)} = 51,900. \text{ PSI}$$

$$M.S. = \frac{190,000.}{51,900.} - 1 =$$

3.66

THREAD SHEAR

FOR EQUAL LOAD DISTRIBUTION: $f_s = \frac{F_w}{\frac{1}{2} D_L} = \frac{3700. \times 2}{\pi \times .171 \times 1.5 \times .171}$

$$= 53,700. \text{ PSI}$$

FOR 1ST THREAD CARRYING 22.2% OF THE TOTAL LOAD ($2/(N+1)$)

$$f_s = \frac{.222}{.125} \times 53,700. = 95,400. \text{ PSI}, M.S. =$$

0.19



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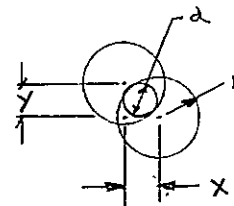
5.3 SHAFT ANALYSIS

5.3.6 BOLT PRELOAD REQUIRED

THE MATING SURFACES OF THE HOT DISPLACER CRANK AND COLD DISPLACER CRANK WILL BE TREATED AS A "CULAR" WITH O.D. OF ".2" IN. AND I.D. OF ".188 IN. (BOLT D.I.A.).

$$d = 2r = (x^2 + y^2)^{1/2} \quad \begin{array}{l} x = .24 \\ y = .22 \\ r = .3335 \end{array}$$

$$= .341 \text{ IN.}$$



$$A_c = \frac{\pi}{4} (.341^2 - .188^2) = .0636 \text{ IN}^2$$

$$V = 49.2 \text{ LBS} \quad (X = 5.355 \text{ IN}) \quad \text{REF. PG. 5-20}$$

REQUIRED AXIAL LOAD ASSUMING ALL SHEAR TRANSMITTED BY FRICTION.

$$P = \frac{V}{\mu} = \frac{49.2}{.10} = 492 \text{ LBS.}$$

TO PREVENT SEPARATION UNDER MOMENT LOADING

$$M = 26.1 \text{ IN-LBS. (REF. PG 5-21)} \quad I = \frac{\pi}{64} (.341^4 - .188^4) = 6.02 \times 10^{-4} \text{ IN}^4$$

$$f_b = \frac{Mc}{I} = \frac{26.1 \times .172}{6.02 \times 10^{-4}} = 7,500 \text{ P.S.I.}$$

$$P_R = 7,500 \times .0636 = 477 \text{ LBS.}$$

APPLYING A FACTOR OF SAFETY OF 2.25

$$P_R = 1070.$$

$$\text{USE } P_R = 1100 \text{ LBS.}$$



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5.3 SHAFT ASSY

5.3.6 BOLT PRELOAD (PN 852697)

THE THREADS WILL BE "MOLY COATED", BASED ON MoS₂.

$$\mu = .05 \text{ TO } .15$$

AXIAL LOAD LOAD REQD = $P = 1100 \text{ LBS.}$

$$\begin{aligned} T &= \frac{P (D_h + D_p)}{K} \\ &= \frac{1100 \times (.33 + .170)}{12} \\ &= \frac{550}{K} \end{aligned}$$

FOR $\mu = .15$, $K = 12.5$

$$T = 44 \text{ IN-LBS.}$$

USE $T = 45 \text{ TO } 50 \text{ IN-LBS.}$

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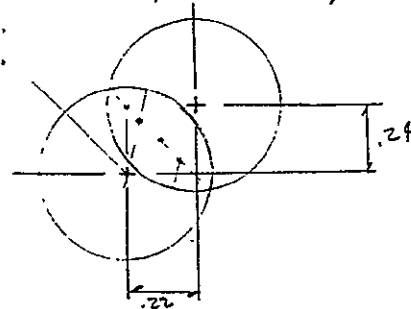
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5.3 SHAFT ANALYSIS

5.3.7 SHEAR PINS, COLD END CRANK TO HOT END CRANK

SINCE IT WAS ASSUMED THAT THE VIBRATORY INERTIA LOADS AND THE PRESSURE LOADS OCCUR AT ANY POINT OF SHAFT ROTATION, THE MAX TORQUE OCCURS WHERE THE LOAD IS $\perp$ TO THE LINE CONTAINING THE CRANK E'S. NEGLECT FRICTION (CONSERVATIVE).



$$T = P_c r$$

$$P_c = 28.7 + .6 = 29.3 \text{ LBS.}$$

(REF. PG 5-14)

$$T = 29.3 \times .163 = 4.78 \text{ IN-LB.}$$

$$P_{PT} = \frac{T}{r} = 13.1 \text{ LBS.}$$

$$r = \frac{1}{2} (.22^2 + .24^2)^{1/2} = .163$$

$$d = .366$$

$$P_{Pi} = \frac{P_c}{2} = 14.7 \text{ LBS.}$$

$$P_p = (13.1^2 + 14.7^2)^{1/2} = 19.7 \text{ LB.}$$

FOR .063 DIA PIN (#566-015-9005)
 CR27 TYPE 18-8

$$A = \frac{\pi}{4} (.063^2) = 0.00312 \text{ IN}^2$$

$$f_s = \frac{19.7}{.00312} = 6,300. \text{ PSI}$$

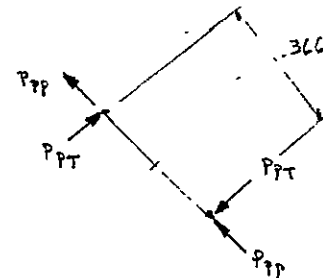
$$F_{Su} = 50,000. \text{ PSI} \quad F_{Ty} = 30,000. \text{ PSI} \quad F_{Tu} = 75,000 \text{ PSI}$$

FOR 301 STAINLESS

$$\text{ASSUMING } F_{Sy} = .6 F_{Ty} = 18,000. \text{ PSI}$$

$$M.S. = \frac{18,000.}{6,300.} - 1 =$$

1.86



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5.4 CONNECTING ROD, HOT DISPLACEMENT

LOAD $P = \text{VIBRATION} + \text{PRESSURE}$
 $= 88.2 + 20.0 = 108.2 \text{ LBS}$
(REF. PG 5-14)

BOLT

$$D_{12} = 0.10 \quad A = \frac{\pi}{4} (.10)^2 = 0.00785 \text{ IN}^2$$

$$f_s = \frac{108.2}{0.00785} = 13,800. \text{ PSI}$$

MAT'L: PH 13-8 Mo $F_{ty} = 190,000. \text{ PSI}$ (MIL-HDBK-4)
ASSUME $F_{sy} = .60 F_{ty} = 114,000. \text{ PSI}$

BENDING MOMENT - ASSUME LOAD ACTS AT $\frac{1}{2} L$ OR $.067''$.

$$M = 108.2 \times .067 = 7.25 \text{ IN-LBS}$$

$$Z = \frac{\pi}{32} (.100)^3 = 0.0000982$$

$$f_b = \frac{7.25}{0.0000982} = 73,800. \text{ PSI}$$

$$R_s = \frac{13,800.}{114,000.} = .121$$

$$R_b = \frac{73,800.}{190,000.} = .388$$

$$M_r S = \frac{1}{(.121^2 + .388^2)^{.5}} - 1 =$$

$$1.46$$

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CALC. NO. C6263 SHEET NO. 5-27

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5.4 CONNECTING ROD, HOT DISPLACER

WRIST PIN

$$P = 108, \text{ LBS.} \quad (\text{SEE PRECEDING PAGE})$$

$$D = .25" \quad A = \frac{\pi}{4} (.25)^2 = .049 \text{ IN}^2$$

$$f_s = \frac{108}{2 \times .049} = 1,100, \text{ PSI}$$

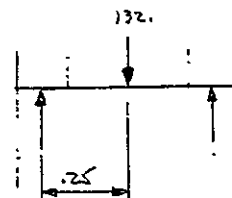
$$M = \frac{108}{2} \times .25$$
$$= 13.5 \text{ IN-LB. (CONSERVATIVE)}$$

$$Z = \frac{\pi}{32} (.25)^3 = 0.00153 \text{ IN}^3$$

$$f_b = \frac{13.5}{.00153} = 8,800, \text{ PSI}$$

MATL: TUNGSTEN - CARBIDE CA 310
 $F_{su} \approx 450,000, \text{ PSI}$

M.S. = HIGH



HIGH

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5.4 CONNECTING ROD, HOT DISPLACER

WRIST PIN RETAINER

$$P = 108, \text{ LBS.} \quad (\text{REF. PG 5-26})$$

SHEAR STRESS AT THREADS

$$A_s = \pi (.3125)(.30)(.50) = 0.147 \text{ in}^2$$

$$f_t = \frac{108}{.147} = 733. \text{ PSI}$$

PRELOAD REQUIRED TO PREVENT SEPARATION OF THE WRIST PIN RETAINER AND DISPLACER

$$P_c = P \left(\frac{K_c}{K_t + K_c} \right)$$

K_c = STIFFNESS OF COMPRESSION ELEMENT

K_t = STIFFNESS OF TENSILE ELEMENT

$$K_{\text{SHIM}} = \frac{.296 \times 26 \times 10^6}{.060} = 172 \times 10^6 \text{ LB/IN.}$$

$$K_{\text{DISPLACER}} = \frac{.296 \times 26 \times 10^6}{.253} = 30.4 \times 10^6 \text{ LB/IN.}$$

$$K_c = \left[\frac{1}{K_{\text{SHIM}}} + \frac{1}{K_{\text{DISPLACER}}} \right]^{-1} = 24.6 \times 10^6 \text{ LB/IN.}$$

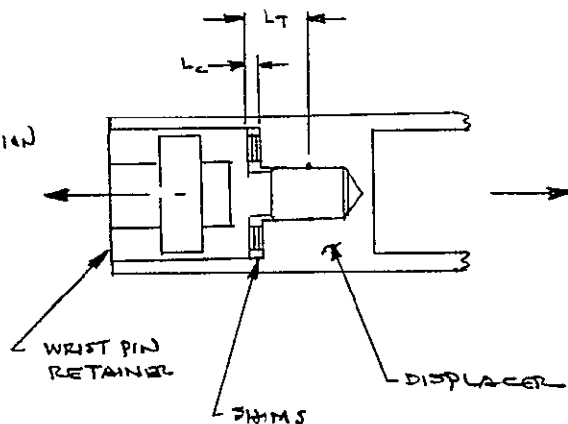
K_t = STIFFNESS OF "STUD"

$$A_t = \frac{\pi}{4} (.25)^2 = .0491 \text{ in}^2$$

$L = .313$ (FROM SHOULDER TO MID POINT OF THREADS)

$E = 29.4 \times 10^6 \text{ PSI}$ (MATERIAL: P18-13-8 Mo.)

$$K_t = \frac{.0491 \times 29.4 \times 10^6}{.313} = 4.61 \times 10^6 \text{ LB/IN.}$$



SHIM: MATERIAL: CRES TYPE 18-8

$E = 26 \times 10^6 \text{ PSI}$

O.D. = .719 IN.

I.D. = .375 IN.

$A = 0.296 \text{ in}^2$

$L = .060 \text{ IN.}$

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PART NO. 852569
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CALC. NO. C6263 SHEET NO. 5-29
MODEL NO. 1/4 W. V. M.
CHECKED BY _____

5.4 CONNECTING ROD, HOT DISPLACER

WRET PIN RETAINER

PRELOAD (CONT'D.)

$$P_c = P \left(\frac{K_c}{K_T + K_c} \right) = 108. \left(\frac{24.6}{4.61 + 24.6} \right) \\ = \underline{91.0 \text{ LB}}$$

TIGHTENING TORQUE

THREAD DATA = $\frac{5}{16}$ - 24 UNF
P.A. = .2854

$\frac{P_T}{P} = .340$ P.A. ND = 6.85, f = .25 (REF. "SCREW THREAD TORQUE"
by M.D. CREECH, MACHINE
DESIGN, MAY 1963.)

$$T_1 = P \left(\frac{P_T}{P} \right) \frac{D}{2} \\ = 108. (.340) \left(\frac{.2854}{2} \right) = \underline{5.24 \text{ IN-LB}}$$

$$T_2 = \text{NUT FACE FRICTION TORQUE} = P f R \\ = 108. \times .25 \times .274 = \underline{7.40 \text{ IN-LB}}$$

R = MEAN RADIUS OF
SHIM
= .274

$$T = T_1 + T_2 = \underline{12.6 \text{ IN-LB.}}$$

USE T = 60. IN-LB

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CALC. NO. C6263 SHEET NO. 5-30
MODEL NO. 1/4 W. V.M.
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CONNECTING ROD, COLD DISPLACER

LOAD $P = 29.3 \text{ LBS.}$ (REF. PG. 5-25)

BOLT

O.K. BY COMPARISON TO HOT DISPLACER BOLT. SMALLER LOAD
FOR SAME SIZE BOLT.

WRIST PIN

O.K. BY INSPECTION.

WRIST PIN RETAINER

TIGHTENING TORQUE : USE $T = 60 \text{ IN-LBS}$ - SAME AS ON
HOT DISPLACER



SECTION 6
CRANKSHAFT HOUSING STRESS ANALYSIS

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74-9896-2

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CALC. NO. 66263 SHEET NO. 6-1
MODEL NO. 1/4 W.V.M.
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G. HOUSING ASSY

G.1 TASKS

G.2 HOUSING AT CROSS TUBE JUNCTION

G.3 HOUSING AT SPHERE/CYLINDER JUNCTION

G.4 HOUSING AT TUBULAR SECTION, COLD END

G.5 FLANGE ASSY.

G.6 INNER HOUSING, DRIVE MOTOR

G.7 OUTER HOUSING, DRIVE MOTOR

G.8 FLANGE, OUTER HOUSING.



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PART NO. 852586

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CALC. NO. C 6263 SHEET NO. 6-2

MODEL NO. 1/4 W. V.M.

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6.1 TASKS

THE ANALYSIS OF THE HOUSING ASSY CONSISTS OF THE FOLLOWING TASKS:

- DETERMINE STRENGTH OF HOUSING AT CROSS TUBE JUNCTION
- DETERMINE STRESSES AT SPHERE / CYLINDER JUNCTION DUE TO PRESSURE AND VIBRATORY LOADING
- DETERMINE STRESSES IN TUBULAR SECTION, COLD END DUE TO PRESSURE AND VIBRATORY LOADING.
- DETERMINE NUT PRELOAD REQUIRED AND STRESS AT FLANGE ASSY.
- DETERMINE STRESSES IN INNER HOUSING, DRIVE MOTOR DUE TO PRESSURE LOADING.
- DETERMINE STRESSES IN OUTER HOUSING, DRIVE MOTOR DUE TO VIBRATION
- DETERMINE STRESS AT WELDED SECTION OF FLANGE FOR OUTER HOUSING OF DRIVE MOTOR.

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CALC. NO. C6263 SHEET NO. 6-3
MODEL NO. 1/4 W.V.H.
CHECKED BY _____

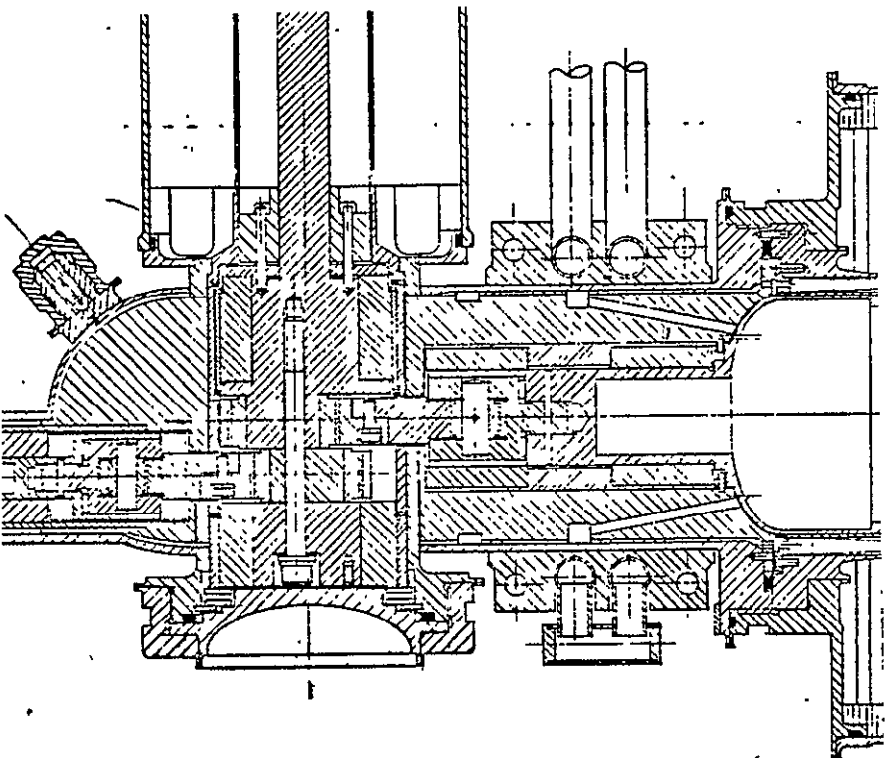


FIG. 8-1 HOUSING ASSY.



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CALC. NO. C6263 SHEET NO. 6-4
 MODEL NO. 1/4 W. V. M.
 CHECKED BY _____

6.2 SUMMIT CROSS TUBE INTERSECTION

THE ALLOWABLE PRESSURE FOR THE HOUSING WILL BE BASED ON THE METHOD OF REF 2, PAGE 67.

$$R_H = 1.250 \quad t_H = 0.064$$

$$R_B = 1.156 \quad t_B = 0.125$$

$$F_{allow} = 90,000 \text{ psi}$$

DETERMINE p_H - ALLOWABLE PRESSURE FOR INTERACT HEADS

$$t_H = \frac{p_H R_H}{F_{all} + 0.9 p_H}$$

$$p_H = \frac{t_H F_{all}}{R_H - 0.4 t_H}$$

$$= \frac{.064 \times 90,000}{1.25 - 0.4 \times .064} = 4700 \text{ psi}$$

$\frac{5760}{1.224}$

PRESSURE REDUCTION RATIO p/p_H

$$\frac{p}{p_H} = \frac{(R_H/t_H) - 0.4}{0.8 R_H (R_B - t_B) + R_B t_B - 0.4 t_H (R_B - t_B) + t_B + 0.2 t_H} - 0.4$$

$$= \frac{(1.250/.064) - 0.4}{0.8 \times 1.250 (1.156 - .125) + 1.156 \times .125 - 0.4 \times .064 (1.156 - .125) + .125 + 0.2 \times .064} - 0.4$$

$\frac{10428378}{1.224}$

$$= 0.70750$$



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CALC. NO. C6263 SHEET NO. 6-5

MODEL NO. 1/4 W.V.M.

CHECKED BY _____

G.2 SUMP / CROSS TUBE INTERSECTION

ALLOWABLE PRESSURE

$$P = .70750 \gamma_H = .70750 \times 4700.$$

$$= \underline{3325. \text{ psi}} \quad \text{BASED ON THE FATIGUE ALLOWABLE.}$$

$$= 3325 \times \frac{150,000.}{70,000}$$

$$= \underline{5550. \text{ psi}} \quad \text{BASED ON YIELD}$$

$$= \underline{6650. \text{ psi}} \quad \text{BASED ON ULTIMATE}$$

MARGIN OF SAFETY

$$\underline{\text{OPERATING}}, \quad \text{M.S.} = \frac{3325.}{1250.} - 1 =$$

1.66

$$\underline{\text{PROOF}}, \quad \text{M.S.} = \frac{5550.}{2060.} - 1 =$$

1.69

$$\underline{\text{BURST}}, \quad \text{M.S.} = \frac{6650.}{2800.} - 1 =$$

1.38



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CALC. NO. C 6263 SHEET NO. 6-6
MODEL NO. 1/4 W.V.M.
CHECKED BY _____

6.3 SPHERE / CYLINDER JUNCTION

$$R_s = 1.258 / 1.299$$

$$R_{ms} = 1.254$$

$$t_s = .068 / .064$$

$$r_{oc} = .6325 / .6175$$

$$r_{mc} = .625$$

$$t_c = 0.099 / .089$$

USING THE METHOD OF REF. 8, SECTION 3:

STRESS DUE TO ρ

$$\rho = \frac{r_c}{R_s} \left(\frac{R_s}{t_s} \right)^K = \frac{.625}{1.254} \left(\frac{1.254}{.064} \right)^{.43} = 2.20$$

$$t_c / t_s = 1.39$$

$$\frac{f_{max}}{R_s / 2 t_s} = 3.1 \quad (\text{FROM FIG. 3.6, PG 96, REF 8})$$

$$f_{max} = \frac{3.1 \times 1.254 \times 1250.}{2 \times .064} = 38,000 \text{ PSI AT OPERATING}$$

STRESS DUE TO SHEAR LOAD

THE STRESS DUE TO SHEAR LOADS IS NEGLIGIBLE FOR
VALUES OF $\rho > 1.0$. SEE FIG. 3.14, REF 8.



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CALC. NO. C6263 SHEET NO. 6-7
 MODEL NO. 1/4 W. V. M.
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6.3 SPHERE / CYLINDER JUNCTION

THE SUPPORT REACTIONS WILL BE COMPUTED FOR THE MOUNTING SCHEME SHOWN IN THE SKETCH.

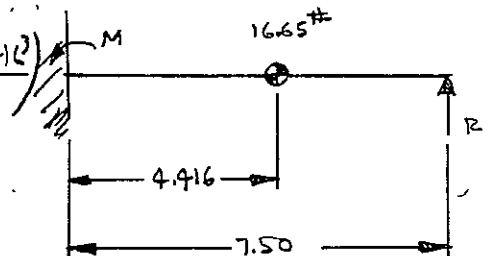
STATIC REACTIONS

$$R_1 = \frac{1}{2} \times 16.65 \left(\frac{3 \times 4.416^2 \times 7.50 - 4.416^3}{7.50^3} \right)$$

$$R_1 = 6.959 \text{ \#}$$

$$R_2 = 16.65 - 6.959$$

$$= 9.691 \text{ LBS.}$$



$$M = \frac{1}{2} \times 16.65 \left(\frac{4.416^3 + 2 \times 4.416 \times 7.50^2 - 3 \times 4.416^2 \times 7.50}{7.50^3} \right)$$

$$= 21.33 \text{ IN-LB. STATIC}$$

VIBRATORY LOAD

FROM THE ANALYSIS OF THE COLD END SHELL, THE SECOND MODE FREQUENCY WAS 1120 CPS. (REF SECTION 8).

AT 1120 CPS, THE RANDOM VIBRATION 30 RESPONSE, WITH AN ASSUMED AMPLIFICATION FACTOR OF 10, 15:

$$LF = 3 \left(\frac{\pi}{2} \times 0.045 \times 10 \times 1120 \right)^{1/2} = 84.4 \text{ G}$$

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CALC. NO. C-6263 SHEET NO. 6-8
 MODEL NO. 1/4 W. V.M.
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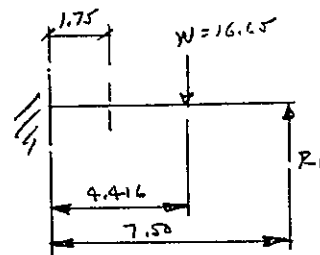
6.3 SPHERE/CYL. JUNCTION

STRESS DUE TO M

$$\text{MOMENT} = L.F. [R_1(7.50 - 1.75) - w(4.416 - 1.75)]$$

2.66

$$M = 84.4 (6.959 \times 5.75 - 16.65 \times 2.66) \\ = 369, \text{ IN-LB}$$



USING THE METHOD OF REF. 8,

$$\frac{f_{max}}{\frac{M}{\pi r^2 t_s} \left(\frac{R_1}{t_s} \right)^{1/2}} = 1.8 \quad \text{from FIG. 3.12, pg 104, REF 8.}$$

$$f_{max} = \frac{1.8 \times 369.}{\pi \times .625 \times .064} \times \left(\frac{1.254}{.064} \right)^{1/2} = 37,400. \text{ psi}$$

TOTAL STRESS DUE TO OPERATING PRESSURE AND VIBRATION

$$f_T = 38,000. + 37,400. = \underline{\underline{75,400. \text{ psi}}}$$



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CALC. NO. C6263 SHEET NO. 6-9
 MODEL NO. 1/4 W.V.M.
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6.3 SPHERE / CYLINDER JUNCTION

MARGINS OF SAFETY

LIFE $F_2 = 90,000 \text{ psi}$

$$M.S. = \frac{90,000}{75,400} - 1 =$$

$$\frac{0.19}{\text{LIFE}}$$

PROOF PRESSURE (w/o VIB. STRESS)

$$f = \frac{2060}{1250} (38,400) = 62,600 \text{ psi}$$

$$M.S. = \frac{150,000}{62,600} - 1 =$$

$$\frac{1.40}{\text{proof}}$$

BURST PRESSURE

$$f = \frac{2800}{1250} (38,000) = 85,100 \text{ psi}$$

$$M.S. = \frac{175,000}{85,100} - 1 =$$

$$\frac{1.06}{\text{BURST}}$$

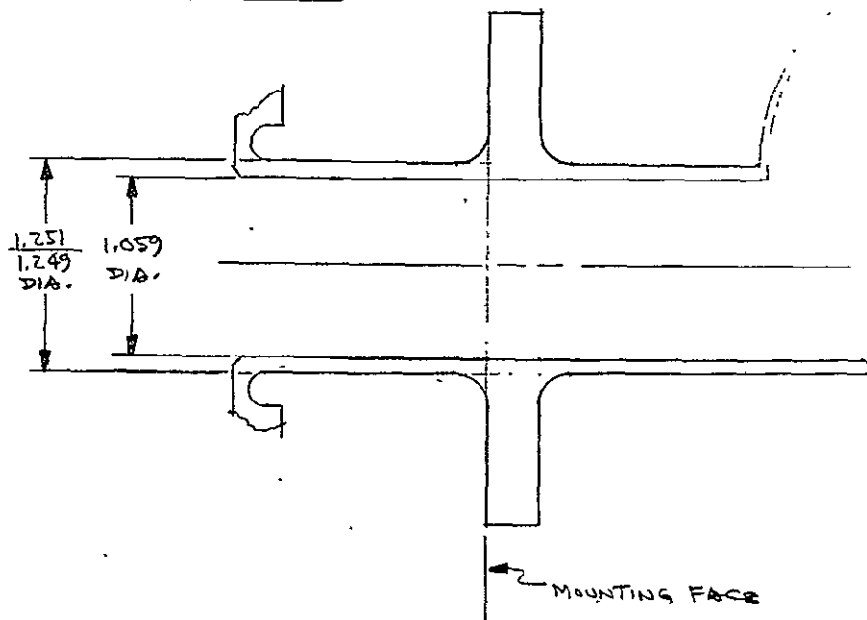
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 PART NO. 852586
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CALC. NO. C6263 SHEET NO. 6-10
 MODEL NO. 1/4 V.V.M.
 CHECKED BY _____

6.4 TUBULAR SECTION, COLD END



THE MOMENT AT THE MOUNTING FACE WILL BE OBTAINED FROM THE MODEL USED IN THE COLD END SHELL ANALYSIS (SECTION 8). THE MOMENT WILL BE INTERPOLATED FROM THE MOMENTS AT STATIONS 8 AND 9 OF THE COLD END SHELL MODEL (REF. PG 8-42). THE MOMENTS ON PAGE 8-53 ARE FOR 39.2 G'S. RANDOM VIBRATION LOADING IS 35.0 G'S.

$$M = \left[\frac{163.46 + (8.3125 - 7.3125)(181.89 - 163.46)}{(8.4625 - 7.3125)} \right] \times \frac{35.0}{39.2}$$

$$= 160.1 \text{ IN-LBS}$$

$$I = \frac{\pi}{64} (D_o^4 - D_i^4) = \frac{\pi}{64} (1.249^4 - 1.059^4) = .0577 \text{ IN}^4$$

$$f_b = \frac{160.1 \times 1.249}{.0577 \times 2} = 1,700. \text{ PSI}$$

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DATE 22 JAN 74CALC. NO. c6263 SHEET NO. 6-11PART NO. 852586MODEL NO. 1/4 W.V.M.PREPARED BY MORIMOTO

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6.4 TUBULAR SECTION, COLD END

$$f_b = \frac{1.824 \cdot pR}{t} = \frac{1.824 \times 1250 \times .577}{.095} = 13,800. \text{ PSI - OPERATING}$$

$$f_c = \frac{pR}{2t} = \frac{1250 \times .577}{2 \times .095} = 3,800. \text{ PSI - OPERATING}$$

$$f_b + f_c = 17,600. \text{ PSI}$$

STRESS DUE TO OPERATING PRESSURE PLUS VIBRATION

$$f = 1,700 + 17,600 = 19,300. \text{ PSI}$$

FATIGUE ALLOWABLE IS 90,000. PSI FOR 10^8 CYCLES.

$$M.S. = \frac{90,000.}{19,300.} - 1 =$$

3.66DEFLECTION AT OUTER BEARING ϕ

USING THE DEFLECTION AND SLOPE OF STATION 8, COLD END SHELL MODEL (REF PG 8-42),

$$y = .000296 \times 35.0/39.2 = \underline{0.000264 \text{ IN.}}$$

$$\theta = .000289 \times 35.0/39.2 = \underline{0.000258 \text{ RAD.}}$$



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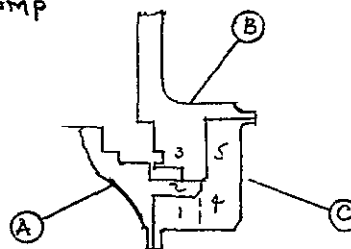
CALC. NO. C 6263 SHEET NO. 6-12
 MODEL NO. 1/4 W. V.M.
 CHECKED BY _____

G.S FLANGE ASSY

NUT PRELOAD

JOINT FLEXIBILITY

- (A) PIN 852565 , CAP , CLOSURE , SUMP
- (B) PIN 852585 , HSG ASSY , MACHINED
- (C) PIN 852592 , RING , RETAINING , SUMP



ITEM	O.D.	I.D.	L	A	$S = \frac{4}{3}AE$
1	2.58	2.06	.190	1.895	3.457×10^{-9}
2	2.58	2.06	.090	1.895	1.638×10^{-9}
3	2.688	2.00	.282	2.533	3.839×10^{-9}
4	3.06	2.58	.250	2.126	4.054×10^{-9}
5	3.06	2.688	.411	1.679	8.437×10^{-9}

$$\frac{\Delta P_{NUT}}{P_{APPLIED}} = \frac{S_1 + S_2}{\Sigma S} = \frac{5.095 \times 10^{-9}}{2.143 \times 10^{-8}} = .238$$

$$P_{NUT} = P_{PRELOAD} + .238 P_{APPLIED}$$

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CALC. NO. C6263 SHEET NO. 6-13
 MODEL NO. 1/4 W V.M.
 CHECKED BY _____

6.5 FLANGE ASSY

NUT PRELOAD

$$\frac{F_A}{T} = \frac{2}{\left(\frac{1}{\sqrt{R}} - f_t \sin \lambda \right) \left(\frac{\tan \lambda + f_t \cos \lambda}{\sqrt{R}} \right) + \frac{f_n D_m}{\cos \xi}}$$

F_A = AXIAL LOAD, LB

T = TORQUE, IN-LBS.

FOR 2.6875 - 20 (N BUTT - 3) THREAD

λ = HELIX ANGLE = .05 RAD = 2.8648°

ϕ = THREAD PRESSURE ANGLE = 7°

$\sqrt{R} = (1 + \tan^2 \lambda + \tan^2 \phi)^{1/2} = 1.01758^{1/2} = 1.00875$

f_t = THREAD FRICTION FACTOR = .12

f_n = NUT FRICTION FACTOR = .12

D_m = MEAN CONTACT DIA. AT NUT FACE = 2.223 IN.

$\xi = (180^\circ - \text{COUNTER SINK ANGLE}) \div 2 = 0.$

$D_p = 2.6875$ IN.

$$\frac{F_A}{T} = \frac{1}{.08599 D_p + .06 D_m} = 2.744$$

$$F_A = 2.744 T$$

F IN LBS
 T IN IN-LBS

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CALC. NO. C6263 SHEET NO. G-14

MODEL NO. 1/4 W. V.M.

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G.5 FLANGE ASSY

NUT PRELOAD

APPLIED LOADS

CONSIDER SEAL O.D. AS PRESSURIZED AREA.

SEAL: AP 20-2313-7-SP

O.D. = 2.316 (max)

$$P_A = \frac{\pi}{4} \times 2.316^2 \times 1250. = \underline{5,270. \text{ LBS AT MAX. OPER. PRESS.}}$$

$$= 4,213 \times 2080. = \underline{8,760. \text{ LBS AT PROOF PRESSURE}}$$

$$= 4,213 \times 2800. = \underline{11,800. \text{ LBS AT BURST PRESSURE}}$$

NUT LOAD

$$\text{FOR } T = \underline{210. \text{ FT-LB}} = 2520. \text{ IN-LBS (MIN.)}$$

$$P_{\text{PRELOAD}} = 2.744T = \underline{6910. \text{ LBS.}}$$

AT PROOF PRESSURE

$$P_{\text{NUT}} = P_{\text{PRELOAD}} + .238 P_{\text{APPLIED}}$$

$$= 6910. + .238 \times 8760. = \underline{9000. \text{ LBS.}}$$

AS SHOWN ON THE DIAGRAM (NEXT PAGE), THE JOINT WILL NOT SEPARATE AT PROOF PRESSURE.

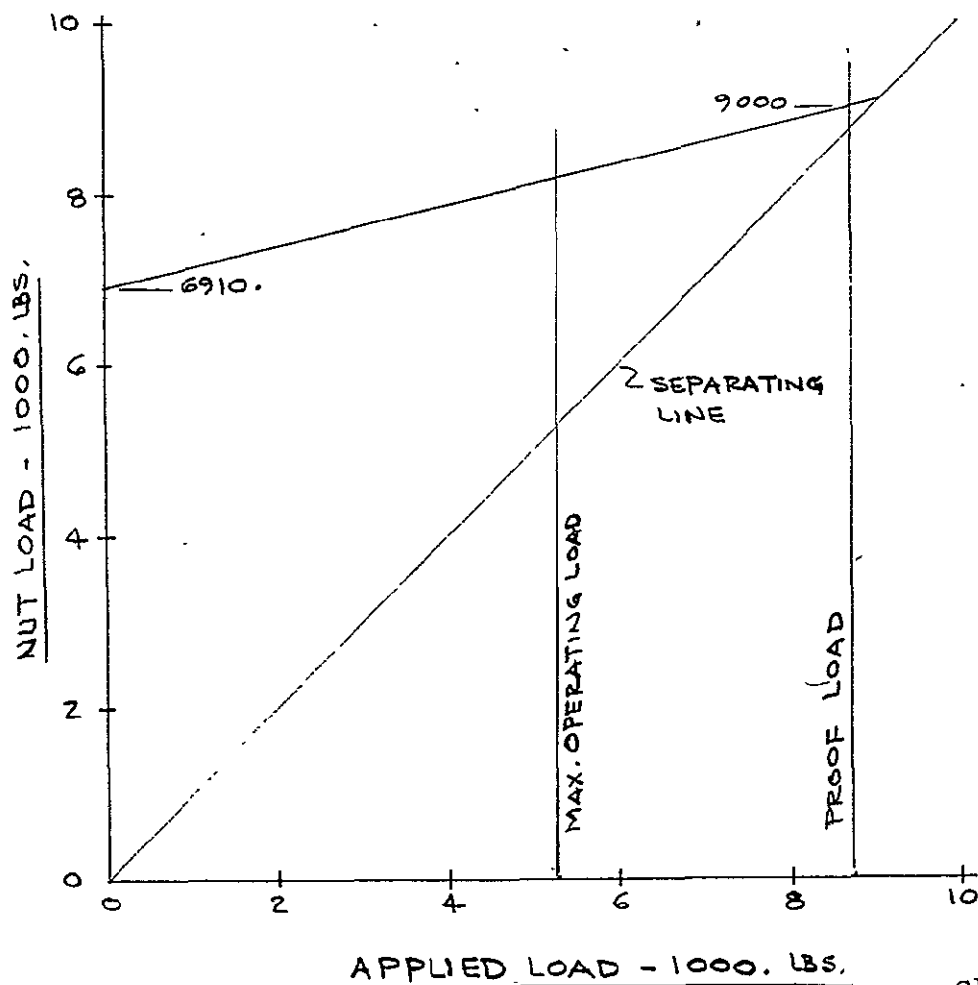


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CALC. NO. C 6263 SHEET NO. 6-15
MODEL NO. 1/4 W. V.M.
CHECKED BY _____

6.5 FLANGE ASSY

$$T = 210. \text{ FT-LBS. (MIN.)}$$
$$P_{\text{NUT}} = P_{\text{PRELOAD}} + .238 P_{\text{APPLIED}}$$
$$P_{\text{PRELOAD}} = 2.744 T \text{ (IN-LB)}$$



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PART NO. 852586

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CALC. NO. 66263 SHEET NO. 6-16

MODEL NO. 1/4 W. V.M.

CHECKED BY _____

6.5 FLANGE ASSY

THREAD SHEAR

CHECK SHEAR OF EXTERNAL THD AT MINOR DIA. OF INTERNAL THD

2.6875 - 20 ← (N) BUTT - 3. THREAD

ASSUME $G = .0045$ (REF. NBS HDBK H28)

D_o = MAJOR DIA. OF EXT. THD = 2.683 IN.

D_m = MINOR DIA. OF INT. THD = $D_{BASIC} - 1.2 p$

$$= 2.6875 - 1.2 \times .05 = \underline{2.628 \text{ IN.}}$$

THICKNESS OF EXT. THD. AT 1.314 RADIUS

$$t = \left(\frac{D_o - D_m}{2} \right) \tan 7^\circ + F + \left(\frac{D_o - D_m}{2} \right) \tan 45^\circ$$

$$= \left(\frac{2.683 - 2.628}{2} \right) \tan 7^\circ + .16316 \times .05 + .0275$$

$$= \underline{0.0390 \text{ IN.}}$$

$$\text{SHEAR AREA PER THD} = A_s = .0390 \times \pi \times 2.628 = \underline{0.322 \text{ IN}^2}$$

$$\text{NO. OF ENGAGED THD} = .158 \times 20 = \underline{3.} \quad (\text{1ST THD CARRIES 50\% OF THE LOAD})$$

SHEAR STRESS AT BURST

$$f_s = \frac{.50 \times 11,800.}{.322} = \underline{18,300. \text{ PSI}}$$

FOR INCO 718, $F_{TU} = 180. \text{ KSI}$

$$F_{su} = .6 \times F_{TU} = 108. \text{ KSI}$$

$$MS = \frac{108,000.}{18,300.} - 1 =$$

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HIGH



DATE 17 May 73
 PART NO. 852590
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CALC. NO. C6243 SHEET NO. 6-17
 MODEL NO. 1/4 W.V.M.
 CHECKED BY _____

G.6 INNER HOUSING, DRIVE MOTOR
ELLIPSOID / CYLINDER JUNCTION

$$f_h = \frac{1.128 P \cdot R}{t}$$

REF. 9, PG 485

$$f_h = \frac{1.128 \times .617 \times 1250}{.012} = 72,500.75 \text{ PSI OPERATING}$$

$$= 119,000.75 \text{ PSI PROOF}$$

$$= 162,000.75 \text{ PSI BURST}$$

$$M.S. = \frac{180,000.}{162,000.} - 1 =$$

$$\frac{.11}{.11}$$

CYLINDER - AT OUTBO EDGE OF STATOR

t UNDER STATOR IS .008, SUPPORTED BY STATOR PLATES.
 CYL. / STATOR CLEARANCE IS .0001 / .0005 ON DIAMETER.

$$f_b = \frac{1.824 P R}{t} \quad (\text{ASSUMING RIGID AT EDGE})$$

$$= \frac{1.824 \times 2800 \times .17}{.030} = 119,000.75 \text{ PSI (BURST)}$$

$$f_t = \frac{P R}{2t} = 33,600.75 \text{ PSI}$$

$$f_b + f_t = 153,000.75 \text{ PSI (AT BURST)}$$

$$M.S. = \frac{180,000.}{153,000.} - 1 =$$

$$= \frac{150,000.}{102,000.} - 1 =$$

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$$\frac{.18}{.18} \text{ BURST}$$

$$\frac{.47}{.47} \text{ YIELD}$$

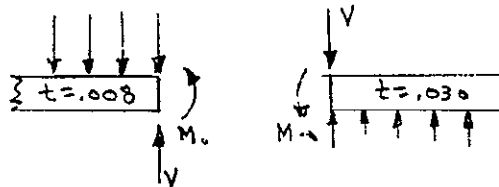


DATE 17 May 72
 PART NO. 852590
 PREPARED BY MORIMOTO

CALC. NO. C6263 SHEET NO. 6-18
 MODEL NO. 1/4 W.V.M.
 CHECKED BY _____

6.6 INNER HOUSING, DRIVE MOTOR

CYLINDER - JUNCTION OF $t=.008$ & $t=.030$ SECTIONS



$$\delta_1 = \frac{p_1 R_1^2}{E_1 t_1} - \frac{V_0}{2 D_1 \lambda_1^3} - \frac{M_0}{2 D_1 \lambda_1^2}$$

$$\theta_1 = -\frac{M_0}{\lambda_1 D_1} - \frac{V_0}{2 D_1 \lambda_1^2}$$

$$\theta_2 = \frac{M_0}{\lambda_2 D_2}$$

$$\delta_1 = 0, \delta_2 = 0, \theta_1 = \theta_2$$

$$\frac{V_0}{2 D_1 \lambda_1^3} + \frac{M_0}{2 D_1 \lambda_1^2} = \frac{p_1 R_1^2}{E_1 t_1}$$

$$\frac{V_0}{2 D_1 \lambda_1^2} + M_0 \left(\frac{1}{D_1 \lambda_1} - \frac{1}{D_2 \lambda_2} \right) = 0$$

$$V_0 + \lambda_1 M_0 = \frac{p_1 R_1^2 (2 D_1 \lambda_1^3)}{E_1 t_1}$$

$$V_0 + 2 D_1 \lambda_1^2 M_0 \left(\frac{1}{D_1 \lambda_1} - \frac{1}{D_2 \lambda_2} \right) = 0$$

$$V_0 + M_0 \left(\frac{\lambda_1}{2} - \frac{2 D_1 \lambda_1}{D_2 \lambda_2} \right) = 0$$

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 PART NO. 852590
 PREPARED BY Mosamoto

CALC. NO. C6263 SHEET NO. 6-19
 MODEL NO. 1/4 W. V.M.
 CHECKED BY _____

6.6 INNER HOUSING, DRIVE MOTOR

CYLINDER - $t = .008$ & $t = .030$ JUNCTION

$$2D_1\lambda_1 \tilde{M}_0 \left(\frac{1}{D_1\lambda_1} - \frac{1}{D_2\lambda_2} \right) + \lambda_1 M_0 = \frac{P_1 R_1}{E_1 t_1} (2D_1\lambda_1^3)$$

$$M_0 \left(3 - \frac{2D_1\lambda_1}{D_2\lambda_2} \right) = \frac{P_1 R_1}{E_1 t_1} \times 2D_1\lambda_1^3$$

$$D_1 = \frac{E_1 t_1^3}{12(1-\mu^2)}$$

$$\lambda_1 = \frac{1.285}{(R_1 t_1)^{1/4}}$$

$$\tilde{\lambda}_1 = \frac{1.65}{R_1 t_1}$$

$$\begin{aligned} \frac{D_1 \lambda_1}{D_2 \lambda_2} &= \frac{E_1 t_1^3}{12(1-\mu^2)} \times \frac{12(1-\mu^2)}{E_2 t_2^3} \times \frac{1.285}{(R_1 t_1)^{1/4}} \times \frac{(R_2 t_2)^{1/4}}{1.285} \\ &= \frac{t_1^3}{t_2^3} \times \frac{(R_2 t_2)^{1/4}}{(R_1 t_1)^{1/4}} = \left(\frac{t_1}{t_2} \right)^3 \left(\frac{R_2 t_2}{R_1 t_1} \right)^{1/4} \end{aligned}$$

$$\frac{P_1 R_1}{E_1 t_1} \times \frac{2 \times E_1 t_1^3}{12(1-\mu^2)} \times \frac{1.65}{R_1 t_1} = \frac{P_1 R_1 t_1 (1.65)}{6(1-\mu^2)}$$



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 PREPARED BY M. MOTO

CALC. NO. C6263 SHEET NO. 6-20
 MODEL NO. 1/4 W. V. M.
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6.6 INNER HOUSING, DRIVE MOTOR

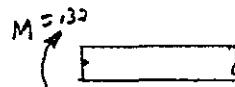
CYLINDER - $t = .008$ & $t = .030$ JUNCTION

$$M_0 \left[1 - \frac{2 \times (.030)^3}{3 \times (.008)} \left(\frac{.700 \times .008}{.685 \times .030} \right)^{1/2} \right] = \frac{p_1 \times .685 \times .030 \times 1.65}{3 \times 6 (1-.34)} \quad \substack{.52207 \\ 1.2350}$$

$$M_0 (-17.352306) = .0020729 p_1$$

$$M_0 = -.00011946 p_1$$

$$= -.334 \text{ IN-LBS.}$$



$$V_0 + \lambda_1 M_0 = \frac{p_1 R_1}{E t_1} (2 D, \lambda_1^3)$$

$$\begin{aligned} V_0 + \frac{1.285}{(.685 \times .030)^{1/2}} \times (-.334) &= \frac{p_1 R_1 t_1 (1.65) \times 1.285}{6 (1-.34) (R_1 t_1)^{1/2}} \\ &= \frac{p_1 \times .685 \times .030 \times 1.65 \times 1.285}{6 \times .91 (.685 \times .030)^{1/2}} \quad \substack{.042571 \\ .78271} \\ &= .055667 p_1 \end{aligned}$$

$$V_0 = .055667 \times 2800. + 2.99394 = \underline{158.9 \text{ LB/IN.}}$$

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CALC. NO. C6263 SHEET NO. 6-21
 MODEL NO. 1/4 W. V.M.
 CHECKED BY _____

6.6 INNER HOUSING, DRIVE MOTOR

CYLINDER - $t = .008$ IN. PORTION

THIS PORTION OF THE CYLINDER IS RESTRAINED FROM
 RADIAL EXPANSION BY THE STATOR

$$f_T = \frac{pR}{2t} = \frac{2800 \times .70}{2 \times .008} = 123,000 \text{ PSI}$$

$$f_b = \frac{6M}{t^2} = \frac{6 \times .334}{.008^2} = 31,300 \text{ PSI}$$

$$f_b + f_T = 154,000 \text{ PSI}$$

$$M.S. = \frac{180,000}{154,000} - 1 =$$

.17

THE CLEARANCE BETWEEN THE PRESSURE DOME & STATOR
 IS .0001 / .0005 ON THE DIAMETER.

$$p = ? \text{ AT } \Delta D = .0005 \text{ IN.}$$

$$p = \frac{\Delta R E t}{R^2} = \frac{.0005 \times 30 \times 10^6 \times .008}{.70^2} = 122 \text{ PSI}$$

$$f_A (\text{AT } \Delta D = .0005) = \frac{\Delta R E}{R} = \frac{.0005 \times 30 \times 10^6}{.70} = 15,000 \text{ PSI}$$



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 PART NO. 852570
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CALC. NO. C6263 SHEET NO. 6-22
 MODEL NO. 1/4 W. V. M.
 CHECKED BY _____

G.6 INNER HOUSING, DRIVE MOTOR

FLANGE

REF. 11, pg. 142:

$$M = \frac{P (R_o - R_c)}{1 + \frac{\beta t_f}{2} + \frac{(1 - \mu^2)}{2 \beta R_c} \left(\frac{t_f}{t_c} \right)^3 \ln \left(\frac{R_o}{R_c} \right)}$$

$$t_f = .090 \quad R_o = .825$$

$$t_c = .060 \quad R_c = .650$$

$$P = \frac{7 R_o}{2 R_c} = \frac{2800 \times .825}{2 \times .650} = 1465 \text{ LB / IN OF CIRC. AT INNER RADIUS (R_c)}$$

$$\beta = \frac{1.285}{(R_c t_c)^{1/2}} = \frac{1.285}{(.650 \times .060)^{1/2}} = 6.51$$

$$M = \frac{1465 \cdot (.825 - .650)}{1 + \frac{6.51 \times .090}{2} + \frac{.91}{2 \times 6.51 \times .650} \times \left(\frac{.090}{.060} \right)^3 \ln \left(\frac{.825}{.650} \right)}$$

$$= 200.0 \text{ IN-LB / IN.}$$

$$M_{NET} = M - (\text{MOMENT DUE TO } p \text{ ACTING ON FLANGE FACE, } M')$$

$$M' = M \times \frac{\beta_{22}}{\pi \beta_1} = M \times \frac{.227}{\pi \times .135} = .535 M \quad (\text{REF. 4, FOR } \beta's)$$

$$M_{NET} = .465 M$$

$$= 93.0 \text{ IN-LB / IN.}$$

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DATE 17 MAY 73

PART NO. 852590

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CALC. NO. C6263 SHEET NO. 6-23

MODEL NO. 1/4 W.V.M.

CHECKED BY _____

G.6 INNER HOUSING, DRIVE MOTOR

FLANGE

CYLINDER STRESSES

$$f_b = \frac{6 \times 93,0}{1,060} = 155,000 \text{ PSI (AT BURST)}$$

$$f_t = \frac{2800 \times 1,650}{2 \times 1,060} = 15,000 \text{ PSI}$$

$$f_b + f_t = 170,000 \text{ PSI}$$

$$M.S. = \frac{180,000}{170,000} - 1 =$$

0.06

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CALC. NO. C 6263 SHEET NO. 6-24
 MODEL NO. 1/4 W.V.M.
 CHECKED BY _____

6.7 OUTER HOUSING, DRIVE MOTOR

VIBRATORY LOADS

THE FREQUENCY ESTIMATE WILL CONSIDER THE FLEXIBILITIES OF THE OUTER HOUSING AND THE CRANKSHAFT HOUSING FLANGE.

FREQUENCY, LATERAL VIBRATION

$$f_L = \frac{3.13}{\delta_L K}$$

$$\delta_L = \frac{WL^3}{3EI} + \theta L$$

$$\text{WHERE } \theta = \frac{M}{\alpha Et^3}$$

REF. 4, PAGE 197 & 216

$$= \frac{WL^3}{3EI} + \frac{ML}{\alpha Et^3}$$

$$W = \text{STATIC WT} = 5.00 \text{ LBS} \quad \left. \begin{array}{l} \text{REF. WT. REPORT, APPENDIX A} \\ L = 3.40 - 1.55 = 1.85 \text{ IN.} \end{array} \right\}$$

$$L = 3.40 - 1.55 = 1.85 \text{ IN.}$$

$$I = \frac{\pi}{64} (3.013^4 - 2.893^4) = .607 \text{ IN.}^4$$

$$E_1 = 10. \times 10^6 \text{ PSI} - \text{ALUM ALLOY}$$

$$t = \text{FLANGE THICK.} = .088$$

$$E_2 = 29.8 \times 10^6 \text{ PSI, INCO 718}$$

$$a = 1.397 \text{ IN.}$$

$$R_0 = 1.052 \text{ IN.}$$

$$\alpha = 156, \text{ FROM } R_0/a = .753$$

REF. DWG. 852585

$$\delta_L = \frac{5. \times 1.85^3}{3 \times 10. \times 10^6 \times .607} + \frac{5.00 \times 1.85 \times 1.85}{156. \times 29.8 \times 10^6 \times .088^3}$$

$$= 7.140 \times 10^{-6} \text{ IN.}$$

$$f_L = 1170 . \text{ CPS.}$$

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CALC. NO. C6263 SHEET NO. 6-25
MODEL NO. 1/4 W.V.M.
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6.7 OUTER HOUSING, DRIVE MOTOR

VIBRATORY LOADS

RANDOM VIBRATION 3 σ RESPONSE

$$\ddot{X}_L = 3 \left(\frac{\pi}{2} \times .045 \times 10. \times 1170 \right)^{1/2} = \underline{86.3 \text{ G's (LATERAL)}}$$

LATERAL DEFLECTION AT C.G. DUE TO 86.3 G's

$$Y_L = \underline{0.000616 \text{ IN.}}$$

FREQUENCY, AXIAL VIBRATION

$$\delta_A = \frac{WL}{AE_1} + \frac{\alpha W a^2}{E_2 t^3}$$

$$\alpha = 0.0021 \text{ FOR } a/P_0 = 1.33$$

$$A = \frac{\pi}{4} (3.013^2 - 2.893^2) = 0.557 \text{ IN}^2$$

$$\delta_A = \frac{5.00 \times 1.85}{.557 \times 10. \times 10^6} + \frac{.0021 \times 5.00 \times 1.33^2}{29.8 \times 10^6 \times .088^3}$$

$$= 2.670 \times 10^{-6} \text{ IN.}$$

$$f_A = \underline{1920. \text{ cps.}}$$

RANDOM VIBRATION 3 σ RESPONSE

$$\ddot{X}_A = 3 \left(\frac{\pi}{2} \times .045 \times 10 \times 1920 \right)^{1/2} = \underline{111. \text{ G's (AXIAL)}}$$

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PART NO. 852591
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CALC. NO. C6263 SHEET NO. 6-26
MODEL NO. 1/4 W.V.M.
CHECKED BY _____

6.7 OUTER HOUSING, DRIVE MOTOR.

HOLD-DOWN SCREWS

$$P_{HO} = \left(\frac{Z}{NR} \times \cos \frac{180^\circ}{N} \right) M$$

$$N = 8 \text{ (#6-32 SCREWS)}$$

$$R = 1.70 \text{ IN.}$$

LATERAL LOAD FACTOR OF 86.3 G'S

$$M = 86.3 \times 5.00 \times 1.85 = 798. \text{ LBS.}$$

$$P_{MAX} = \frac{Z}{8 \times 1.70} \times \cos \left(\frac{180^\circ}{8} \right) \times 798. = 108. \text{ LBS.}$$

$$F_{T0} = 423. \text{ LBS (REF. MIL-HDBK-5, PG 8-63)}$$

$$\text{ASSUMING } F_e = .5 F_{T0} = 211. \text{ LBS.}$$

$$M.S. = \frac{211.}{108.} =$$

0.95

AXIAL LOAD FACTOR OF 111 G'S

$$P = \frac{5.00 \times 111.}{8} = 69. \text{ LBS. O.K.}$$



DATE 16 May 73PART NO. 852591PREPARED BY MORIMOTOCALC. NO. C6263 SHEET NO. 6-27MODEL NO. 1/4 W.V.M.

CHECKED BY _____

6.7 OUTER HOUSING, DRIVE MOTORFLANGE

$$M = 117. \times .194 = 22.7 \text{ IN-LBS.}$$

$$f_b = \frac{6 M}{b t^2}$$

$$= \frac{6 \times 22.7}{.50 \times .090^2}$$

$$= 33,600. \text{ PSI}$$

TO DETERMINE LOCAL STRESSES IN CYLINDER DUE TO FLANGE LOAD, ASSUME BENDING OCCURS ALONG AN ARC OF .25 INCH RADIUS.

$$f_b = \frac{6 M}{b t^2}$$

$$= \frac{6 \times 22.7}{\pi (.25) (.060)^2}$$

$$= 48,200. \text{ PSI.}$$

$$f_t = \frac{117.}{.50 \times .060} = 39,00. \text{ PSI}$$

$$f_t + f_b = 52,100. \text{ PSI}$$

FOR 7075-T73 ALUM ALLOY
 $F_{T_u} = 68, \text{ KSI}, F_{T_y} = 56. \text{ KSI}$ REF. MIL-HDBK-5

$$M.S. = \frac{56.}{52.1} - 1 =$$

0.07



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CALC. NO. 66263 SHEET NO. 6-28
MODEL NO. 1/4 W.V.M.
CHECKED BY _____

6.7 OUTER HOUSING, DRIVE MOTOR

PRESS FIT STRESS

PRESS FIT BETWEEN THE HOUSING AND STATOR IS
.0015/.0025 IN.

AT .0025 IN. PRESS

$$f_x = \frac{\Delta D}{D} E = \frac{.0025}{1.45} \times 10 \times 10^6$$
$$= \underline{17,200. \text{ PSI}}$$

THIS STEADY STRESS WILL BE COMPARED TO THE
"THRESHOLD" STRESS FOR STRESS CORROSION (F_{SC}).

$F_{SC} = 43. \text{ KSI (MIN.) FOR 7075-T73 REF. MIL-HDBK-5}$
(SHORT TRANSVERSE) PG 3-10.

$$M.S. = \frac{43.}{17.2} - 1 =$$

$$\frac{1.50}{1}$$



DATE 16 May 73
PART NO. 85259
PREPARED BY Morgan

CALC. NO. C 6263 SHEET NO. 6-29
MODEL NO. 1/4 W.V.M.
CHECKED BY _____

6.7 OUTER HOUSING, DRIVE MOTOR

DEFLECTION AT END (FLAT HEAD)

$p = 15. \text{ PSI}$ EXTERNAL

USE METHOD FROM REF 12, TO COMPUTE DISCONTINUITY STRESS. (f_b).

FROM f_b , COMPUTE $M = \frac{f_b t^2}{6}$

THEN APPLY $\frac{1}{2} M$ TO FLAT PLATE.

$$\frac{T}{t} = 1.0, R = 1.45$$

$$\frac{D}{t} = \frac{2 \times 1.45}{.077} = 37.7$$

$$I_a = 18. \quad \text{REF. 12, PG 14.7.2-11}$$

$$f_{max} = I_a \frac{p R}{t} = 18. \times \frac{15 \times 1.45}{.077} = 5100, \text{ PSI}$$

$$M = 5100 \times \frac{.077^2}{6} = 5.02 \text{ IN-LB/IN.}$$

$$\delta_1 (\text{DUE TO } p) = .00968 \text{ IN (SEE NEXT PAGE)}$$

$$\delta_2 (\text{DUE TO } M) = \frac{6(m-1)(R^2)(M)}{E m t^3} = \frac{2 \times 2 \times 1.45^2 \times 5.02}{3 \times 10^{10} \times .077^3}$$

$$= 0.00462 \text{ IN. (OPPOSITE TO } \delta_1)$$

$$\delta = \delta_1 - \delta_2 = 0.0051 \text{ IN.}$$



DATE 12 May 73
 PART NO. 852591
 PREPARED BY M. Maguire

CALC. NO. C6263 SHEET NO. 6-30
 MODEL NO. 1/4 W. V. M.
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6.7 OUTER HOUSING, DRIVE MOTOR

DEFLECTION AT END DUE TO $\Delta P = 15. \text{psi}$

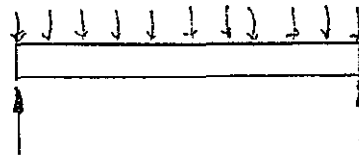
SIMPLY SUPPORTED

$$\delta = \frac{3 W (m-1) (5m+1) R^2}{16 \pi E m^2 t^3}$$

$$m = \frac{1}{R} = 5, \text{ (always)}$$

$$W = 8 \pi R^2$$

$$f_{\max} = \frac{1}{2} \frac{p R^2}{t} = 6,600.9 \text{ psi}$$



$$\delta = \frac{3 \cdot (p \pi R^2) (m-1) (5m+1) R^2}{16 \pi E m^2 t^3}$$

$$= \frac{3 p R^4 (m-1) (5m+1)}{16 E m^2 t^3}$$

$$= \frac{3 \times 15 \times 1.45^4 (2)(16)}{16 \times 14.7 \times 10^6 \times 8 \times .0773} = \frac{1.45^4}{.0773 \times 10^6}$$

$$= .00968 \text{ IN. (SIMPLY SUPPORTED)}$$

FOR FIXED EDGES

$$\delta = \frac{.00968 (m-1)}{(m-1)(5m+1)} = \frac{.00968 \times 8}{2 \times 16} = .00242 \text{ IN.}$$



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CALC. NO. C6263 SHEET NO. 6-31
 MODEL NO. 1/4 W.V.H.
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6.8 FLANGE, OUTER HOUSING

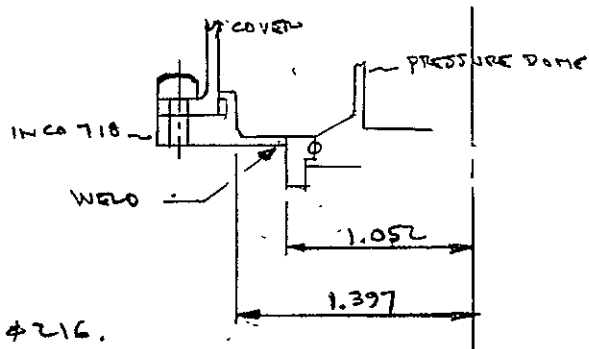
STRESS AT WELD

$$R_o = 1.052$$

$$a = 1.397$$

$$\frac{R_o}{a} = .753$$

REF. 4, PGS 197 & 216.



AT WELD JOINT, ASSUME
 MATL IS IN ANNULAR
 CONDITION.

$$\left. \begin{array}{l} F_{ty} = 125,000 \text{ PSI} \\ F_{ty} = 110,000 \text{ PSI} \end{array} \right\} \text{ REF. MIL-HDBK-5,}$$

$$f = \frac{BM}{at} = \frac{.346 \times 798}{1.397 \times .088} = 25,500.75 \text{ PSI}$$

$$M.S. = \frac{.90 \times 110,000}{25,500} - 1 =$$

2.88



SECTION 7
HOT-END PRESSURE SHELL
STRESS ANALYSIS

DATE 18 JAN 74
PART NO. 852579
PREPARED BY MORIMOTO

CALC. NO. C 6263 SHEET NO. 7-1
MODEL NO. 1/4 V.I. V.M.
CHECKED BY _____

7. HOT END PRESSURE SHELL

7.1 TASKS

7.2 SHELL ANALYSIS

7.2.1 PRESSURE PLUS TEMPERATURE LOADING STRESSES

7.2.2 VIBRATORY STRESSES

7.2.3 COMBINED PRESSURE, TEMP., AND VIBRATORY STRESSES

7.2.4 SHELL AND DISPLACER DEFLECTIONS

7.3 FLANGE ASSY

7.3.1 NOT PRELOAD CALCULATIONS

7.3.2 STRESS ANALYSIS

7.4 SHIELD ASSY, VACUUM



DATE 18 JAN 74
PART NO. 852579
PREPARED BY MORIMOTO

CALC. NO. C6263 SHEET NO. 7-2
MODEL NO. 1/4 W. V.M.
CHECKED BY _____

7.1 TASKS

THE ANALYSIS OF THE HOT END PRESSURE SHELL
CONSISTS OF THE FOLLOWING TASKS:

- DETERMINE SHELL STRESSES DUE TO INTERNAL PRESSURE, TEMPERATURE LOADING AND VIBRATION
- DETERMINE SHELL AND DISPLACEMENT DEFLECTIONS AND COMPARE TO CLEARANCE.
- DETERMINE FLANGE ASSY PRELOAD REQUIRED AND STRESS IN THREADS.
- DETERMINE COLLAPPING PRESSURE AND STRESS OF THE VACUUM SHIELD ASSY.



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DATE 18 Jan 74

PART NO. 852579

PREPARED BY M. J. MOTO

CALC. NO. C-6263 SHEET NO. 7-3

MODEL NO. 14-W.V.M.

CHECKED BY _____

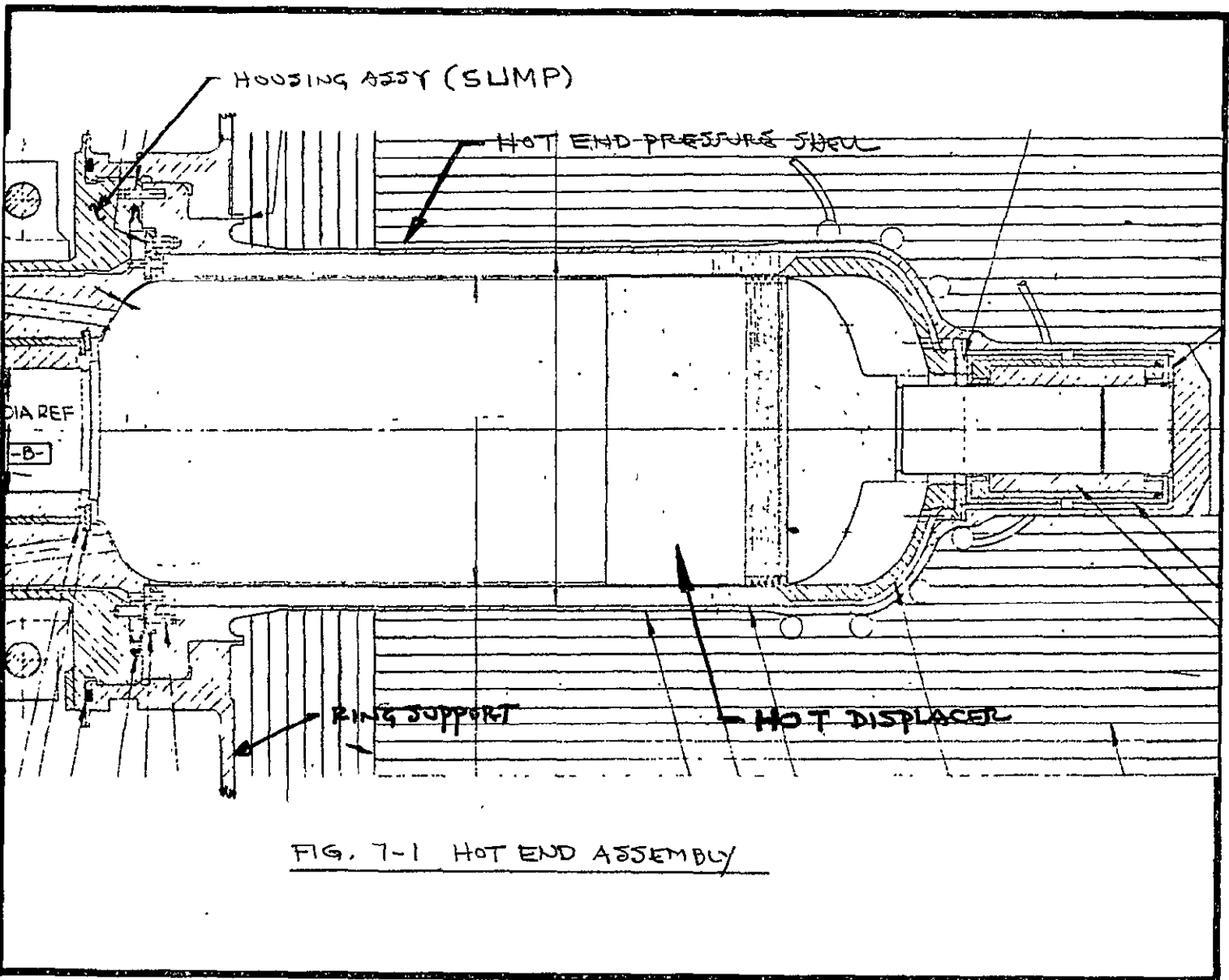


FIG. 7-1 HOT END ASSEMBLY



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PART NO. 852579
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CALC. NO. C6263 SHEET NO. 7-4
MODEL NO. 1/4 W. V.M.
CHECKED BY _____

7.2 SHELL ANALYSIS

THE HOT END PRESSURE SHELL WAS ANALYZED USING A SHELL ANALYSIS PROGRAM DEVELOPED BY A. KALWIN. THE THEORETICAL BASIS FOR THIS SHELL PROGRAM IS CONTAINED IN REF. (13).

THE SHELL ANALYSIS MODEL IS SHOWN ON PAGE 7-6.

THE SHELL WAS ANALYZED FOR 1250 PSI MAX OPERATING PRESSURE AND 2800 PSI BURST PRESSURE, PLUS A TEMPERATURE GRADIENT OF 1200°F AT THE DOME AND 140°F AT THE FLANGE.

THE STRESSES DUE TO VIBRATORY LOADS WERE DETERMINED AND COMBINED WITH STRESSES DUE TO MAX OPERATING PRESSURE.

THE STRESSES ARE TABULATED ON PAGE 7-7. AND PLOTTED ON PAGE 7-8 (FIG. 7-3). THE ALLOWABLE STRESSES ARE ALSO PLOTTED IN FIG. 7-3. THE STRESSES DUE TO BURST PRESSURE WERE NOT PLOTTED BEYOND $X = 4$ INCHES BECAUSE THE STRESSES ARE VERY LOW. THE MAX OPERATING STRESSES WERE NOT PLOTTED FOR $X < 3.0$ INCHES BECAUSE THE STRESSES, WHEN COMPARED TO THE CREEP ALLOWABLE, IS INSIGNIFICANT.

THE MAX OPERATING STRESS AT THE END OF PART 12 IS 39.9 KSI WHICH EXCEEDS THE CREEP ALLOWABLE OF 35. KSI. HOWEVER, THE SHELL IS STRUCTURALLY ADEQUATE BECAUSE:

- 1) AT NOMINAL DESIGN PRESSURE (1000 PSI), THE STRESS REDUCES TO 31.9 KSI, WITH RESULTING M.S. OF 0.10.
- 2) A STRESS LEVEL OF 39.9 KSI DOES NOT IMPLY A STRUCTURAL FAILURE, BUT RATHER A REDUCTION OF EXPOSURE TIME AND/OR AN INCREASE ABOVE THE 0.2 % CREEP. THE CREEP RUPTURE STRESS IS 49. KSI.



DATE 18 JAN 74
PART NO. 852579
PREPARED BY MOTUMOTO

CALC. NO. C6263 SHEET NO. 7-5
MODEL NO. 1/4 W. V.M.
CHECKED BY _____

7.2 SHELL ANALYSIS

THE SHELL FREQUENCY WAS ESTIMATED AT 1180. CPS. WITH AN ASSUMED AMPLIFICATION OF 10, THE 30 RANDOM VIBRATION RESPONSE WAS FOUND TO BE 86.6 G'S. THE RESULTING VIBRATORY STRESSES, WHICH WERE LOW, WERE COMBINED WITH THE STRESSES DUE TO MAXIMUM OPERATING PRESSURE PLUS TEMPERATURE LOADING. THE MAX. COMBINED STRESS WAS 66,600. PSI. THE FATIGUE ALLOWABLE FOR 10⁸ CYCLES IS 90,000. PSI. THIS GIVES AN M.S. OF 0.35.

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CALC. NO. C6263 SHEET NO. 1-6
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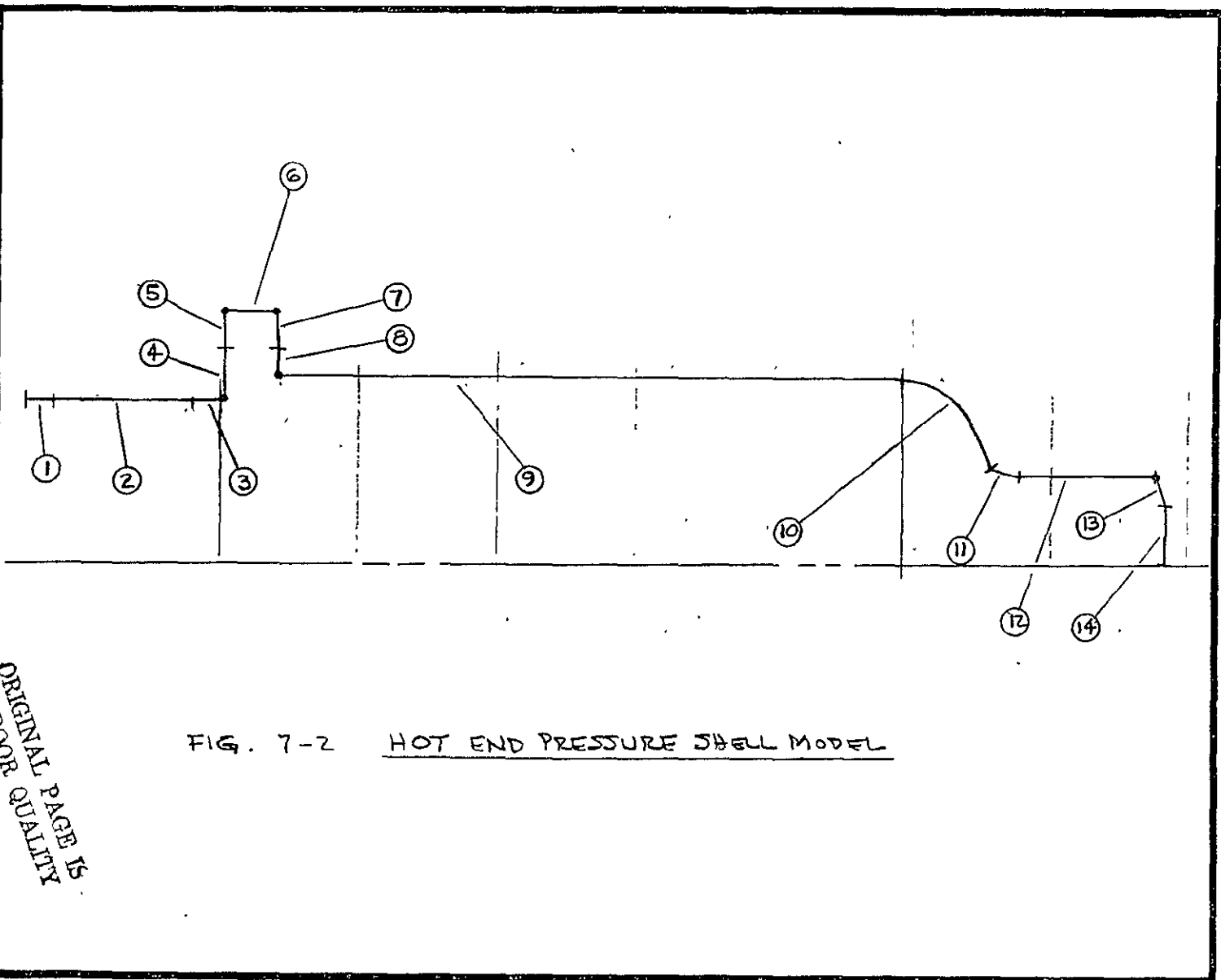


FIG. 7-2 HOT END PRESSURE SHELL MODEL

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DATE 18 JAN 74PART NO. 852579PREPARED BY MORIMOTOCALC. NO. C6263 SHEET NO. 7-7MODEL NO. 1/4 W.V.M.

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7.2.1 SHELL ANALYSIS - PRESSURE PLUS TEMPERATURE

THE COMBINED STRESSES WILL BE COMPUTED FROM THE COMPUTER OUTPUT.

CONDITION	X (IN)	f_L (KSI)	f_R (KSI)	$f_{comb.}$ (KSI)	Follow. (KSI)	M.S.
LONGitudinal	0	162.	50.0	144.	175.	0.22
	.44	99.8	137.	122.		
	1.04	64.2	128.	111.		
	2.07	64.0	128.	111.		
	2.51	62.2	125.	105.		
	3.03	60.1	121.	105.		
	3.55	61.0	121.	105.		
	3.85	91.5	129.	115.	147.	0.28
	3.92	65.6	110.	95.9		
	4.07	36.3	71.8	62.2		
1250 PSI MAX OPERATING	3.03	26.8	53.7	46.5	135.	1.90
	3.55	27.3	53.7	46.5		
	4.07	15.5	32.3	28.0		
	4.44	19.1	6.4	16.8		
	4.64	37.5	15.3	32.7	35.	0.07
	4.99	15.2	33.6	29.1		
	5.20	34.7	17.7	30.1		
	5.31	8.1	18.8	16.3		
	5.98	7.4	14.9	12.9		
	6.57	17.4	4.2	15.7		
	6.65	44.2	10.8	39.9	SEE REMARKS ON PG 7-4	

$$\text{NOTE: } f_{comb.} = \left(f_L^2 + f_R^2 - f_L f_R - 3 \tau^2 \right)^{1/2}$$

$$\tau = \text{SHEAR} = 0.$$



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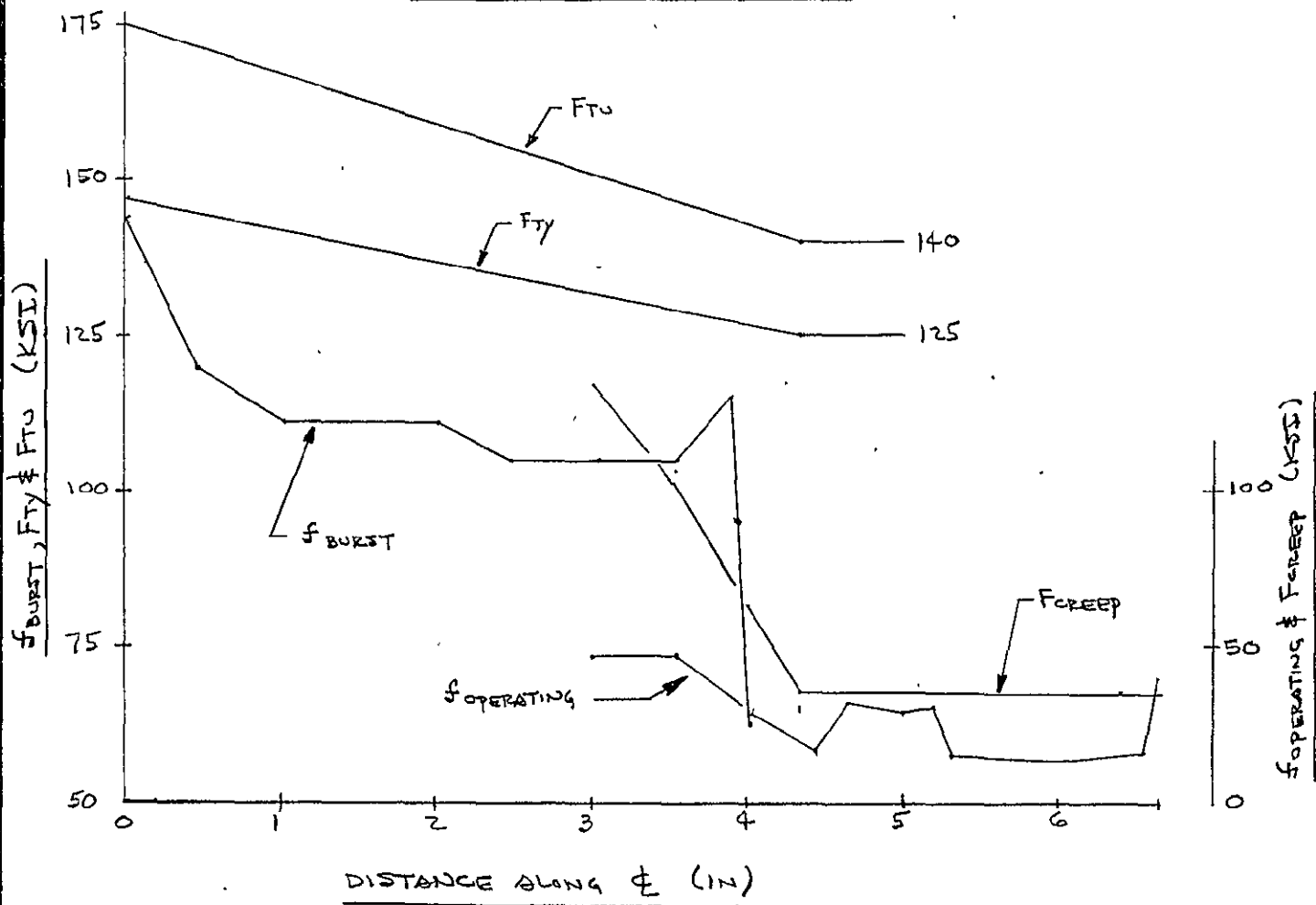
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FIG. 7-3 STRESSES AT MAX OPERATING AND BURST PRESSURES

HOT END PRESSURE SHELL



DATE 18 JAN 74
PART NO. 852579
PREPARED BY MORFASST

CALC. NO. C6263 SHEET NO. 7-8
MODEL NO. 1/4 W.V.V.N.
CHECKED BY _____

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DATE 18 JAN 74
PART NO. 852579
PREPARED BY MOTOMOTO

CALC. NO. 06263 SHEET NO. 7-9
MODEL NO. 4W.V.M.
CHECKED BY _____

7.2.1 SHELL ANALYSIS - PRESSURE PLUS TEMP.

THE SHELL ANALYSIS COMPUTER OUTPUT ARE INCLUDED IN THIS SECTION AS PAGES 7-16 THRU 7-58.

DUE TO THE MODELING TECHNIQUE USED, A FICTITIOUSLY HIGH STRESS LEVEL WAS COMPUTED AT THE END OF PART 10 (REFER TO FIG. 7-2, PG 7-6). THE HIGH STRESS OCCURRED BECAUSE THE GENEROUS FILLET RADIUS WAS NOT INCLUDED AT THE END OF PART 10. HOWEVER, THE FILLET WAS ACCOUNTED FOR IN PART 11. CONSEQUENTLY, THE STRESS AT THE BEGINNING OF PART 11 WAS MUCH LOWER AND WAS USED AS THE STRESS AT THE PART 10 / PART 11 JUNCTION.



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Page 7-9

DATE 15 SEPT 72
 PART NO. 852579
 PREPARED BY MORIMOTO

CALC. NO. C6263 SHEET NO. 7-10
 MODEL NO. 1/4 W.V.M.
 CHECKED BY _____

7.2.2. VIBRATORY STRESSES

FREQUENCY

ESTIMATE BY FINDING THE FREQUENCIES (f_1) OF A UNIFORMLY LOADED CANTILEVER AND (f_2) OF A CANTILEVER WITH AN END LOAD, AND APPLY DUNKERLEY'S FORMULA.

$$f_1 = \frac{3.52}{2\pi} \left(\frac{EI}{WL^4} \right)^{1/2}$$

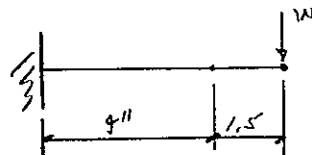
$$L = 4, \text{''}$$

$$W = \frac{\pi}{4} (2.67^2 - 2.57^2) (1.282) = 0.114 \text{ lb/in.}$$

$$f_1 = \frac{3.52}{2\pi} \left(\frac{30 \times 10^6 \times 3.49 \times 386.}{.114 \times 4^4} \right)^{1/2} = 6590. \text{ cps}$$

$$f_2 = \frac{1}{2\pi} \left(\frac{KG}{W} \right)^{1/2} = 3.13 \left(\frac{1}{8} \right)^{1/2}$$

$$\begin{aligned} W &= 1/2 \text{ DISPLACER} + \text{PRESSURE SHELL DOME} \\ &\quad + \text{BRG} + \text{HEATER} + \text{SUPPORT} \\ &\quad + \text{FLOW DISTRIBUTOR (PARTIAL)} \\ &= .47 + .23 + .13 + .04 + .17 + .12 + .11 \\ &= 1.56 \text{ LBS.} \end{aligned}$$



$$\delta = W \left[\frac{L^3}{3EI} + \frac{1.5L^2}{2EI} \right] = \frac{WL^2}{EI} \left(\frac{L}{3} + 1.5 \right)$$

$$= \frac{4 \times (1.33 + 1.5) (1.56)}{29.8 \times 10^6 \times 3.49} = 6.79 \times 10^{-6} \text{ in.}$$

$$f_2 = 3.13 \left(\frac{1}{8} \right)^{1/2} = 1200. \text{ cps.}$$

$$f = \left(\frac{1}{f_1^2} + \frac{1}{f_2^2} \right)^{1/2} = 1180. \text{ cps.}$$

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DATE 18 JAN 74
PART NO. 852579
PREPARED BY MOTIMOTO

CALC. NO. C 6263 SHEET NO. 7-11
MODEL NO. 1/4 W. V.M.
CHECKED BY _____

7.2.2 VIBRATORY STRESS

VIBRATORY LOADS

AT 1180. CPS, THE RANDOM VIBRATION SPECIFICATION APPLIES.
THE 30 RESPONSE, WITH AN ASSUMED AMPLIFICATION FACTOR
OF 10, 15:

$$\begin{aligned} L.F. &= 3 \left(\frac{\pi}{2} \times 0.05 \times T \times f_n \right)^{1/2} \\ &= 3 \left(\frac{\pi}{2} \times 0.045 \times 10. \times 1180 \right)^{1/2} \\ &= \underline{86.6 \text{ G's}} \end{aligned}$$

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CALC. NO. C6263 SHEET NO. 7-12
 MODEL NO. 1/4 W.V.M.
 CHECKED BY _____

7.2.2 VIBRATORY STRESSES

THE PRESSURE SHELL SUPPORTS HALF OF THE DISPLACER WEIGHT (.94#)
 AT THE OUTBOARD BEDRING PLUS THE FOLLOWING ITEMS,

NAME	W	X
SHELL	1.04	11.31
HEATER	0.12	13.25
SUPPORT	0.11	14.25
BEDRING	0.17	14.25
FLOW DIST.	0.570	11.68
SCREEN Assy	0.43	10.50

$$\begin{aligned}\Sigma &= 2.38 \\ \Sigma WX &= 27.812 \\ \bar{X} &= 11.686\end{aligned}$$

* X IS FROM FIXED MOUNTING PLANE. SEE WEIGHT REPORT, APPEND. A.

AT PRESSURE SHELL CYLINDER / FLANGE INTERSECTION, $X = 8.6875$

$$M = 27.812 + \overset{6.698}{.47} \times 14.25 - (\overset{2.85}{2.38} + \overset{2.48}{.47})(8.6875)$$

$$= \underline{\underline{9.750 \text{ IN-LB.}}} \quad \text{AT } 1" \phi$$



DATE 15 JAN 72
PART NO. 852579
PREPARED BY MORIMOTO

CALC. NO. 26263 SHEET NO. 7-13
MODEL NO. 1/4 W.V.M.
CHECKED BY _____

7.2.2 VIBRATORY STRESSES

AT CYL/FLANGE JUNCTION

$$D_i = 2.589$$

$$t = 0.073 \text{ (MIN.)}$$

$$I = \frac{\pi}{64} (2.725^4 - 2.589^4) = 0.501 \text{ IN.}^4$$

$$f_b = \frac{9.758 \times 1.363}{0.501} = 26.5 \text{ PSI AT } 1 \text{ "G"} \\ = \underline{2300. \text{ PSI AT } 86.6 \text{ G'S}}$$

CYLINDRICAL PORTION AT X=9.03

$$D_i = 2.589$$

$$t = .049$$

$$I = \frac{\pi}{64} (2.677^4 - 2.579^4) = 0.349 \text{ IN.}^4$$

$$M = 9.750 - 2.85 \times .343 = 8.77 \text{ IN-LB AT } 1 \text{ G.}$$

$$f_b = \frac{8.77 \times 1.339}{0.349} = 33.6 \text{ PSI AT } 1 \text{ "G"} \\ = \underline{2900. \text{ PSI AT } 86.6 \text{ G'S}}$$



DATE 7 JUNE 73
PART NO. 852579
PREPARED BY MORIMOTO

CALC. NO. C6263 SHEET NO. 7-4
MODEL NO. 1/4 W. V.M.
CHECKED BY _____

7.2.2 VIBRATORY STRESS

OUTER DOME / BEARING JOURNAL (1.25 DIA) JUNCTION

$$\text{RANDOM VIB. LOAD} = P = \frac{1}{2} \text{ DISPLACEMENT WT} \times 86.6$$

$$a = 1.319 \quad b = .693 + k(.065) = .676$$

$$R_s = \frac{a^2}{b} = \frac{1.319^2}{.676} = 2.57 \quad t_s = .065$$

$$r_c = .684 \quad t_c = .096$$

$$t_c/t_s = 1.48$$

$$p = \frac{r_c}{R_s} \left(\frac{R_s}{t_s} \right)^{1/4} = \frac{.684}{2.57} \left(\frac{2.57}{.065} \right)^{1/4} = 1.67$$

$$f_{max} = (\text{S.C.F.}) \left(\frac{M}{\pi r^2 t} \right) \left(\frac{R}{T} \right)^{1/4} \quad (\text{REF. 8, SECTION 3})$$

$$M = PL = .47 \times 86.6 \times .75 = 30.5 \text{ IN-LBS.}$$

$$\text{S.C.F.} = 1.7 \quad (\text{REF. 8, SECTION 3})$$

$$f_{max} = 1.7 \left(\frac{30.5}{\pi \times .684^2 \times .065} \right) \left(\frac{2.57}{.065} \right)^{1/4} \\ = \underline{3,400. \text{ PSI}}$$

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PART NO. 852579

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CALC. NO. C6263 SHEET NO. 7-15

MODEL NO. 1/4 W.V.M.

CHECKED BY _____

7.2.3 COMBINED MAX OPERATING, TEMP, AND VIBRATORY STRESSES

AT CYLINDER/FLANGE JUNCTION

$$f = 64,300. + 2,300. = \underline{66,600. \text{ PSI.}}$$

AT .34 IN. FROM CYL/FLANGE JUNCTION

$$f = 54,500. + 2,900. = \underline{57,400. \text{ PSI}}$$

AT DOME/BEARING JOURNAL JUNCTION

$$f = 30,100. + 3,400. = \underline{33,500. \text{ PSI}}$$

THE FATIGUE ALLOWABLE AT 10^8 CYCLES IS $99,000. \text{ PSI}$

$$M.S. = \frac{99,000.}{66,600.} - 1 =$$

0.35

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KALNINS SHELL STRES ANALYSIS..... HOT END PRESSURE SHELL MORIMOTO JUN 73

STATIC ANALYSTS PARTS= 14 BRANCHES= 0 NUMBFR OF SUBCASES= 2

ANGLFS OF ROTATION OF BOUNDARY CONDITIONS ARE ALFL= -.00000 ALFRS= -.00000

PART NO 1

SI= .00000 SX= .25000-00 IPAR= 5 INC= 2 SHELL TYPE 8 NTP= 0 LAYERS MLY= 1

GENERAL SHELL NO 8 K= .00000 1/RFI= .00000 R= .11930+01 FI= 90.000 DEG

VARIABLE Z-COORDINATES OF THIS PART FOLLOW .

TI1 LINEAR FUNCTION GENERATOR NO. 1 FROM 2 POINTS

Y COORDINATES -.2250-01 -.2250-01

X COORDINATES .0000 .2500-00

TO1 LINEAR FUNCTION GENERATOR NO. 2 FROM 2 POINTS

Y COORDINATES .4150-01 .2250-01

X COORDINATES .0000 .2500-00

LAYER NO 1 FROM Z= .64000-01 TO Z= .45000-01
CONSISTS OF ISOTROPIC MATERIAL, YOUNGS MODULUS E= .29800+08 POISSONS RATIO NU= .30000-00
COEFFICIENTS OF THERMAL EXPANSION AFI= .76000-05 ATHETA= .76000-05 MASS DENSITY RHO= -.00000

PART NO 2

SI= .00000 SX= .22410+01 IPAR= 5 INC= 2 SHELL TYPE 2 NTP= 0 LAYERS MLY= 1

CYLINDRICAL SHELL NO 2 K= .00000 R= .11930+01 PHI= 90.000 DEGREES

LAYER NO 1 FROM Z= -.22500-01 TO Z= .22500-01
CONSISTS OF ISOTROPIC MATERIAL, YOUNGS MODULUS E= .29800+08 POISSONS RATIO NU= .30000-00
COEFFICIENTS OF THERMAL EXPANSION AFI= .76000-05 ATHETA= .76000-05 MASS DENSITY RHO= -.00000

PART NO 3

SI= .00000 SX= .25000-00 IPAR= 5 INC= 2 SHELL TYPE 8 NTP= 0 LAYERS MLY= 1

GENERAL SHELL NO 8 K= .00000 1/RFI= .00000 R= .11930+01 FI= 90.000 DEG

VARIABLE Z-COORDINATES OF THIS PART FOLLOW

TI3 LINEAR FUNCTION GENERATOR NO. 3 FROM 2 POINTS

Y COORDINATES -.2250-01 -.2250-01

X COORDINATES .0000 .2500-00

TO3 LINEAR FUNCTION GENERATOR NO. 4 FROM 2 POINTS

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Y COORDINATES .2250-01 .4150-01

X COORDINATES .0000 .2500-00

LAYER NO 1 FROM Z= .45000-01 TO Z= .64000-01
CONSISTS OF ISOTROPIC MATERIAL, YOUNGS MODULUS E= .29800+08 POISSONS RATIO NU= .30000-00
COEFFICIENTS OF THERMAL EXPANSTON AFI= .76000-05 ATHETA= .76000-05 MASS DENSITY RHO= -.00000

PART NO 4

SI= .00000 SX= .34100-00 IPAR= 5 ING= 3 SHELL TYPE 6 NTP= 0 LAYERS MLV= 1

CONICAL SHELL NO 6 K= .00000 PHI= .000 DEGREES A= .11930+01

LAYER NO 1 FROM Z= -.11100+00 TO Z= .11100+00
CONSISTS OF ISOTROPIC MATERIAL, YOUNGS MODULUS E= .29800+08 POISSONS RATIO NU= .30000-00
COEFFICIENTS OF THERMAL EXPANSTON AFI= .76000-05 ATHETA= .76000-05 MASS DENSITY RHO= -.00000

PART NO 5

SI= .00000 SX= .16600-00 IPAR= 5 ING= 3 SHELL TYPE 6 NTP= 0 LAYERS MLV= 1

CONICAL SHELL NO 6 K= .00000 PHI= .000 DEGREES A= .15340+01

LAYER NO 1 FROM Z= -.11500+00 TO Z= .11500+00
CONSISTS OF ISOTROPIC MATERIAL, YOUNGS MODULUS E= .29800+08 POISSONS RATIO NU= .30000-00
COEFFICIENTS OF THERMAL EXPANSTON AFI= .76000-05 ATHETA= .76000-05 MASS DENSITY RHO= -.00000

PART NO 6

SI= .00000 SX= .50000-01 IPAR= 5 ING= 3 SHELL TYPE 2 NTP= 0 LAYERS MLV= 1

CYLINDRICAL SHELL NO 2 K= .00000 R= .17000+01 PHI= 90.000 DEGREES

LAYER NO 1 FROM Z= -.10000+00 TO Z= .10000+00
CONSISTS OF ISOTROPIC MATERIAL, YOUNGS MODULUS E= .29800+08 POISSONS RATIO NU= .30000-00
COEFFICIENTS OF THERMAL EXPANSTON AFI= .76000-05 ATHETA= .76000-05 MASS DENSITY RHO= -.00000

PART NO 7

SI= .00000 SX= .16600-00 IPAR= 3 ING= 3 SHELL TYPE 6 NTP= 0 LAYERS MLV= 1

CONICAL SHELL NO 6 K= .00000 PHI= 180.000 DEGREES A= -.17000+01

LAYER NO 1 FROM Z= -.12500-00 TO Z= .12500-00
CONSISTS OF ISOTROPIC MATERIAL, YOUNGS MODULUS E= .29800+08 POISSONS RATIO NU= .30000-00
COEFFICIENTS OF THERMAL EXPANSTON AFI= .76000-05 ATHETA= .76000-05 MASS DENSITY RHO= -.00000

PART NO 8

SI= .00000 SX= .20500-00 IPAR= 3 ING= 3 SHELL TYPE 6 NTP= 0 LAYERS MLV= 1

CONICAL SHELL NO 6 K= .00000 PHI= 180.000 DEGREES A= -.15340+01

LAYER NO 1 FROM Z= -.15000-00 TO Z= .15000-00



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CONSISTS OF ISOTROPIC MATERIAL, YOUNGS MODULUS E= .29800+08 POISSONS RATIO NU= .30000-00
COEFFICIENTS OF THERMAL EXPANSION AFI= .76000-05 ATHEA= .76000-05 MASS DENSITY RHO= -.00000

PART NO 9

SI= .00000 SX= .44375+01 IPAR= 20 ING= 3 SHELL TYPE 6 NTP= 0 LAYERS MLY= 1

GENERAL SHELL NO. 8 K= .00000 1/RFI= .00000 R= .13290+01 FI= 90.000 DEG

VARIABLE ELASTIC PROPERTIES OF LAYER NO. 1 FOLLOW

EVAR LINEAR FUNCTION GENERATOR NO. 5 FROM 5 POINTS

Y COORDINATES .2980+08 .2980+08 .2800+08 .2580+08 .2440+08

X COORDINATES .0000 .1250+00 .1875+01 .3625+01 .4438+01

PI LINEAR FUNCTION GENERATOR NO. 6 FROM 2 POINTS

Y COORDINATES .3000+00 .3000+00

X COORDINATES .0000 .4438+01

ALFA LINEAR FUNCTION GENERATOR NO. 7 FROM 3 POINTS

Y COORDINATES .7600-05 .7600-05 .8400-05

X COORDINATES .0000 .1875+01 .4438+01

VARIABLE Z-COORDINATES OF THIS PART FOLLOW

TI LINEAR FUNCTION GENERATOR NO. 8 FROM 2 POINTS

Y COORDINATES -.3900-01 -.3900-01

X COORDINATES .0000 .4438+01

TO LINEAR FUNCTION GENERATOR NO. 9 FROM 7 POINTS

Y COORDINATES .1850+01 .1850+01 .9800-02 .9800-02 .6500-02 .2600-01 .2600-01

X COORDINATES .0000 .1250+00 .3750+00 .2125+01 .3875+01 .4125+01 .4438+01

LAYER NO 1 FROM Z= -.39000-01 TO Z= .39000-01

CONSISTS OF ISOTROPIC MATERIAL, YOUNGS MODULUS E= .29800+08 POISSONS RATIO NU= .30000-00
COEFFICIENTS OF THERMAL EXPANSION AFI= .76000-05 ATHEA= .76000-05 MASS DENSITY RHO= -.00000

PART NO 10

SI= .15708+01 SX= .28476+01 IPAR= 15 ING= 2 SHELL TYPE 5 NTP= 0 LAYERS MLY= 1

ELLIPSOIDAL SHELL NO 5 K= .00000 A= .13290+01 B= .64300-00 DIRECTN= 1.

LAYER NO 1 FROM Z= -.39000-01 TO Z= .26000-01

CONSISTS OF ISOTROPIC MATERIAL, YOUNGS MODULUS E= .24400+08 POISSONS RATIO NU= .30000-00
COEFFICIENTS OF THERMAL EXPANSION AFI= .84000-05 ATHEA= .84000-05 MASS DENSITY RHO= -.00000



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PART NO 11

SI= .00000 SX= .31752-00 IPAR= 6 ING= 1 SHELL TYPE 6 NTP= 0 LAYERS MLY= 1
CONICAL SHELL NO 6 K= .00000 PHI= 109.120 DEGREES A= -.21524+01

VARIABLE Z-COORDINATES OF THIS PART FOLLOW

TI11 LINEAR FUNCTION GENERATOR NO. 10 FROM 2 POINTS

Y COORDINATES -.6000-01 -.2700-01

X COORDINATES .0000 .3175-00

TD11 LINEAR FUNCTION GENERATOR NO. 11 FROM 2 POINTS

Y COORDINATES .8000-01 .2700-01

X COORDINATES .0000 .3175-00

LAYER NO 1 FROM Z= .14000-00 TO Z= .45000-01
CONSISTS OF ISOTROPIC MATERIAL, YOUNGS MODULUS E= .24400+08 POISSONS RATIO NU= .30000-00
COEFFICIENTS OF THERMAL EXPANSTION AFI= .84000-05 ATHETA= .84000-05 MASS DENSITY RHO= -.00000

PART NO 12

SI= .00000 SX= .13300+01 IPAR= 6 ING= 3 SHELL TYPE 2 NTP= 0 LAYERS MLY= 1

CYLINDRICAL SHELL NO 2 K= .00000 R= .60100-00 PHI= 90.000 DEGREES

LAYER NO 1 FROM Z= -.25500-01 TO Z= .25500-01
CONSISTS OF ISOTROPIC MATERIAL, YOUNGS MODULUS E= .24400+08 POISSONS RATIO NU= .30000-00
COEFFICIENTS OF THERMAL EXPANSTION AFI= .84000-05 ATHETA= .84000-05 MASS DENSITY RHO= -.00000

PART NO 13

SI= .00000 SX= .29046-00 IPAR= 6 ING= 1 SHELL TYPE 6 NTP= 0 LAYERS MLY= 1

CONICAL SHELL NO 6 K= .00000 PHI= 157.319 DEGREES A= -.65137-00

VARIABLE Z-COORDINATES OF THIS PART FOLLOW

TI13 LINEAR FUNCTION GENERATOR NO. 12 FROM 2 POINTS

Y COORDINATES -.5000-01 -.8000-01

X COORDINATES .0000 .2905-00

TD13 LINEAR FUNCTION GENERATOR NO. 13 FROM 2 POINTS

Y COORDINATES .5000-01 .8000-01

X COORDINATES .0000 .2905-00

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LAYER NO 1 FROM Z= .10000+00 TO Z= .16000-00
CONSISTS OF ISOTROPIC MATERIAL, YOUNGS MODULUS E= .24400+08 POISSONS RATIO NU= .30000-00
COEFFICIENTS OF THERMAL EXPANSION AFI= .84000-05 ATHETA= .84000-05 MASS DENSITY RHO= -.00000

PART NO 14

SI= .00000 SX= .23300-00 IPAR= 5 ING= 2 SHELL TYPE 6 NTP= 0 LAYERS MLY= 1

CONICAL SHELL NO 6 K= .00000 PHI= 180.000 DEGREES A= -.73300-00

LAYER NO 1 FROM Z= -.80000-01 TO Z= .80000-01
CONSISTS OF ISOTROPIC MATERIAL, YOUNGS MODULUS E= .24400+08 POISSONS RATIO NU= .30000-00
COEFFICIENTS OF THERMAL EXPANSION AFI= .84000-05 ATHETA= .84000-05 MASS DENSITY RHO= -.00000

KALNINS SHELL STRESS ANALYSIS.....7. HOT END PRESSURE SHELL MORINOYO JUN 73

SUBCASE NO 1 FOR FOURIER HARMONIC COS 0 THETA

BOUNDARY CONDITIONS AT STARTING EDGE 1= .00000 3= .00000 5= .00000 7= .00000

BOUNDARY CONDITIONS AT FINAL EDGE 2= .00000 4= .00000 6= .00000 8= .00000

LOADS FOR PART NO 1 SUBCASE NO 1

RING LOADS AT END OF THIS PART ARE G= -.00000 NPHI= -.00000 MPHI= -.00000 N= -.00000
WK= -.00000 UK= -.00000 UTHK= -.00000

SURFACE AND TEMP LOADS ARE P= .12500+04 PFI= -.00000 PTHETA= -.00000 TL= .14000+03 TU= .14000+03

LOADS FOR PART NO 2 SUBCASE NO 1

RING LOADS AT END OF THIS PART ARE G= -.00000 NPHI= -.00000 MPHI= -.00000 N= -.00000
WK= -.00000 UK= -.00000 UTHK= -.00000

SURFACE AND TEMP LOADS ARE P= .12500+04 PFI= -.00000 PTHETA= -.00000 TL= .14000+03 TU= .14000+03

LOADS FOR PART NO 3 SUBCASE NO 1

RING LOADS AT END OF THIS PART ARE G= -.00000 NPHI= -.00000 MPHI= -.00000 N= -.00000
WK= -.00000 UK= -.00000 UTHK= -.00000

SURFACE AND TEMP LOADS ARE P= .12500+04 PFI= -.00000 PTHETA= -.00000 TL= .14000+03 TU= .14000+03

LOADS FOR PART NO 4 SUBCASE NO 1

RING LOADS AT END OF THIS PART ARE G= -.00000 NPHI= -.00000 MPHI= -.00000 N= -.00000
WK= -.00000 UK= -.00000 UTHK= -.00000

SURFACE AND TEMP LOADS ARE P= .12500+04 PFI= -.00000 PTHETA= -.00000 TL= .14000+03 TU= .14000+03

LOADS FOR PART NO 5 SUBCASE NO 1

RING LOADS AT END OF THIS PART ARE G= -.00000 NPHI= -.00000 MPHI= -.00000 N= -.00000
WK= -.00000 UK= -.00000 UTHK= -.00000

SURFACE AND TEMP LOADS ARE P= .12500+04 PFI= -.00000 PTHETA= -.00000 TL= .14000+03 TU= .14000+03

LOADS FOR PART NO 6 SUBCASE NO 1

RING LOADS AT END OF THIS PART ARE G= -.00000 NPHI= -.00000 MPHI= -.00000 N= -.00000
WK= -.00000 UK= -.00000 UTHK= -.00000

SURFACE AND TEMP LOADS ARE P= .12500+04 PFI= -.00000 PTHETA= -.00000 TL= .14000+03 TU= .14000+03

LOADS FOR PART NO 7 SUBCASE NO 1

RING LOADS AT END OF THIS PART ARE G= -.00000 NPHI= -.00000 MPHI= -.00000 N= -.00000



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74-9896-2
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WK= -.00000 UK= -.00000 UTHK= -.00000

SURFACE AND TEMP LOADS ARE P= .12500+04 PFI= -.00000 PTHETA= -.00000 TL= .14000+03 TU= .14000+03

LOADS FOR PART NO 8 SUBCASE NO 1

RING LOADS AT END OF THIS PART ARE G= -.00000 NPHI= -.00000 MPHI= -.00000 N= -.00000

WK= -.00000 UK= -.00000 UTHK= -.00000

SURFACE AND TEMP LOADS ARE P= .12500+04 PFI= -.00000 PTHETA= -.00000 TL= .14000+03 TU= .14000+03

LOADS FOR PART NO 9 SUBCASE NO 1

RING LOADS AT END OF THIS PART ARE G= -.00000 NPHI= -.00000 MPHI= -.00000 N= -.00000

WK= -.00000 UK= -.00000 UTHK= -.00000

SURFACE AND TEMP LOADS ARE P= .12500+04 PFI= -.00000 PTHETA= -.00000 TL= .67000+03 TU= .67000+03

CODE NUMBERS OF VARIABLE LOADS OVER THIS PART, GIVEN BY FGENS BELOW, ARE 4 5

TE1 LINEAR FUNCTION GENERATOR NO. 14 FROM 3 POINTS

Y COORDINATES .1400+03 .1400+03 .1200+04

X COORDINATES .0000 .1250-00 .4438+01

TE0 LINEAR FUNCTION GENERATOR NO. 15 FROM 3 POINTS

Y COORDINATES .1400+03 .1400+03 .1200+04

X COORDINATES .0000 .1250-00 .4438+01

LOADS FOR PART NO 10 SUBCASE NO 1

RING LOADS AT END OF THIS PART ARE G= -.00000 NPHI= -.00000 MPHI= -.00000 N= -.00000

WK= -.00000 UK= -.00000 UTHK= -.00000

SURFACE AND TEMP LOADS ARE P= .12500+04 PFI= -.00000 PTHETA= -.00000 TL= .12000+04 TU= .12000+04

LOADS FOR PART NO 11 SUBCASE NO 1

RING LOADS AT END OF THIS PART ARE G= -.00000 NPHI= -.00000 MPHI= -.00000 N= -.00000

WK= -.00000 UK= -.00000 UTHK= -.00000

SURFACE AND TEMP LOADS ARE P= .12500+04 PFI= -.00000 PTHETA= -.00000 TL= .12000+04 TU= .12000+04

LOADS FOR PART NO 12 SUBCASE NO 1

RING LOADS AT END OF THIS PART ARE G= -.00000 NPHI= -.00000 MPHI= -.00000 N= -.00000

WK= -.00000 UK= -.00000 UTHK= -.00000

SURFACE AND TEMP LOADS ARE P= .12500+04 PFI= -.00000 PTHETA= -.00000 TL= .12000+04 TU= .12000+04

LOADS FOR PART NO 13 SUBCASE NO 1



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RING LOADS AT END OF THIS PART ARE Q= -.00000 NPHI= -.00000 MPHI= -.00000 N= -.00000
WK= -.00000 UK= -.00000 UTHK= -.00000

SURFACE AND TEMP LOADS ARE P= .12500+04 PFI= -.00000 PTHETA= -.00000 TL= .12000+04 TU= .12000+04

LOADS FOR PART NO 14 SUBCASE NO 1

RING LOADS AT END OF THIS PART ARE Q= -.00000 NPHI= -.00000 MPHI= -.00000 N= -.00000
WK= -.00000 UK= -.00000 UTHK= -.00000

SURFACE AND TEMP LOADS ARE P= .12500+04 PFI= -.00000 PTHETA= -.00000 TL= .12000+04 TU= .12000+04

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KALNINS SHELL STRESS ANALYSIS..... HOT END PRESSURE SHELL MORIMOTO JUN 73

DEFLECTIONS AND STRESS RESULTANTS FOR WAVE NUMBER NX= .0 1250 PSI PLUS TEMPERATURE LOADING

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X	W	Q	UPHI	NPHI	RPHI	MPHI	UTHETA	N	NTHETA	MTHETA
MAIN SHELL PART NO 1										
.0000	.00000	.51859+03	.00000	.74031+03	.00000	-.53763+02	.00000	.00000	-.18072+04	-.35407+02
.0250	.25354-04	.45039+03	.61385-04	.74031+03	-.19802-02	-.41655+02	.00000	.00000	-.17076+04	-.28995+02
.0500	.96600-04	.38499+03	.11853-03	.74031+03	-.36714-02	-.31220+02	.00000	.00000	-.15414+04	-.22769+02
.0500	.96601-04	.38499+03	.11853-03	.74031+03	-.36714-02	-.31220+02	.00000	.00000	-.15414+04	-.22769+02
.0750	.20653-03	.32363+03	.17174-03	.74031+03	-.50757-02	-.22372+02	.00000	.00000	-.13257+04	-.17004+02
.1000	.34803-03	.26717+03	.22139-03	.74031+03	-.61968-02	-.14998+02	.00000	.00000	-.10759+04	-.11898+02
.1000	.34803-03	.26716+03	.22139-03	.74031+03	-.61969-02	-.14998+02	.00000	.00000	-.10759+04	-.11898+02
.1250	.51406-03	.21617+03	.26790-03	.74031+03	-.70403-02	-.89677+01	.00000	.00000	-.80612+03	-.75743+01
.1500	.69778-03	.17093+03	.31170-03	.74031+03	-.76120-02	-.41410+01	.00000	.00000	-.52890+03	-.40961+01
.1500	.69778-03	.17092+03	.31170-03	.74031+03	-.76120-02	-.41407+01	.00000	.00000	-.52890+03	-.40960+01
.1750	.89245-03	.13147+03	.35326-03	.74031+03	-.79177-02	-.37261-00	.00000	.00000	-.25523+03	-.14722+01
.2000	.10915-02	.97635+02	.39310-03	.74031+03	-.79624-02	.24799+01	.00000	.00000	.52822+01	.33203-00
.2000	.10915-02	.97631+02	.39310-03	.74031+03	-.79624-02	.24802+01	.00000	.00000	.52778+01	.33210-00
.2250	.12884-02	.69041+02	.43172-03	.74031+03	-.77491-02	.45531+01	.00000	.00000	.24443+03	.13872+01
.2500	.14768-02	.45177+02	.46970-03	.74031+03	-.72783-02	.59716+01	.00000	.00000	.45527+03	.17915+01

MAIN SHELL PART NO 2										
.0000	.14768-02	.45173+02	.46970-03	.74031+03	-.72783-02	.59718+01	.00000	.00000	.45527+03	.17916+01
.2241	.24194-02	-.26193+02	.77614-03	.74031+03	-.14773-02	.04162+01	.00000	.00000	.15148+04	.13248+01
.4482	.24771-02	-.87573+01	.10589-02	.74031+03	.34373-03	.32716-00	.00000	.00000	.15796+04	.98149-01
.4482	.24792-02	-.86045+01	.10588-02	.74031+03	.33038-03	.32166-00	.00000	.00000	.15820+04	.96497-01
.6723	.24116-02	.62727-00	.13438-02	.74031+03	.18790-03	-.29853-00	.00000	.00000	.15060+04	-.89560-01
.8964	.23923-02	.70647-00	.16312-02	.74031+03	.19940-04	-.76164-01	.00000	.00000	.14843+04	-.22849-01
.8964	.23946-02	.87685-00	.16311-02	.74031+03	.54886-05	-.81578-01	.00000	.00000	.14869+04	-.24473-01
1.1205	.23965-02	.23083-00	.19187-02	.74031+03	-.51184-05	.33690-01	.00000	.00000	.14890+04	.10107-01
1.3446	.23933-02	-.36218-00	.22062-02	.74031+03	.33714-04	.31561-01	.00000	.00000	.14854+04	.94682-02
1.3446	.23961-02	-.15244-00	.22062-02	.74031+03	.15842-04	.24760-01	.00000	.00000	.14887+04	.74280-02
1.5687	.23925-02	-.10802+01	.24938-02	.74031+03	-.11113-05	-.97400-01	.00000	.00000	.14845+04	-.29220-01
1.7928	.24127-02	-.11013+01	.27812-02	.74031+03	-.22955-03	-.41706-00	.00000	.00000	.15073+04	-.12512-00
1.7928	.24150-02	-.92901-00	.27812-02	.74031+03	-.24419-03	-.42256-00	.00000	.00000	.15099+04	-.12677-00
2.0169	.25073-02	.11260+02	.30653-02	.74031+03	-.47277-03	.36213-00	.00000	.00000	.16136+04	.10864+00
2.2410	.24422-02	.36312+02	.33660-02	.74031+03	.18869-02	.58759+01	.00000	.00000	.15404+04	.17628+01

MAIN SHELL PART NO 3										
.0000	.24450-02	.36521+02	.33460-02	.74031+03	.18690-02	.58691+01	.00000	.00000	.15436+04	.17607+01
.0250	.23911-02	.37579+02	.33774-02	.74031+03	.24338-02	.67957+01	.00000	.00000	.15363+04	.32872+01
.0500	.23237-02	.38258+02	.34082-02	.74031+03	.29536-02	.77449+01	.00000	.00000	.15073+04	.47654+01
.0500	.23237-02	.38258+02	.34082-02	.74031+03	.29536-02	.77449+01	.00000	.00000	.15073+04	.47654+01
.0750	.22438-02	.38098+02	.34386-02	.74031+03	.34348-02	.87016+01	.00000	.00000	.14561+04	.61275+01
.1000	.21523-02	.36627+02	.34689-02	.74031+03	.38812-02	.96389+01	.00000	.00000	.13821+04	.72998+01
.1000	.21523-02	.36633+02	.34689-02	.74031+03	.38813-02	.96390+01	.00000	.00000	.13821+04	.72999+01

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.1250	.20500-02	.33368+02	.34990-02	.74031+03	.42943-02	.10518+02	.00000	.00000	.12848+04	.82034+01
.1500	.19378-02	.27816+02	.35293-02	.74031+03	.46731-02	.11288+02	.00000	.00000	.11638+04	.87545+01
.1500	.19378-02	.27821+02	.35293-02	.74031+03	.46732-02	.11288+02	.00000	.00000	.11638+04	.87545+01
.1750	.18166-02	.19485+02	.35598-02	.74031+03	.50150-02	.11886+02	.00000	.00000	.10191+04	.88659+01
.2000	.16874-02	.78678+01	.35908-02	.74031+03	.53152-02	.12235+02	.00000	.00000	.85075+03	.84484+01
.2000	.16874-02	.78671+01	.35908-02	.74031+03	.53153-02	.12235+02	.00000	.00000	.85075+03	.84484+01
.2250	.15513-02	.75204+01	.36224-02	.74031+03	.55678-02	.12248+02	.00000	.00000	.65941+03	.74134+01
.2500	.14095-02	.27150+02	.36548-02	.74031+03	.57654-02	.11824+02	.00000	.00000	.44611+03	.56754+01
MAIN SHELL PART NO 4										
.0000	.36548-02	.74031+03	.14095-02	.27151+02	.57655-02	.11824+02	.00000	.00000	.76893+03	.13485+03
.0227	.37856-02	.75461+03	.14328-02	.12404+02	.57364-02	.27792+01	.00000	.00000	.75418+03	.12737+03
.0455	.39156-02	.76892+03	.14562-02	.15384+01	.56968-02	.17619+02	.00000	.00000	.74024+03	.11969+03
.0682	.40445-02	.78322+03	.14797-02	.14734+02	.56467-02	.32699+02	.00000	.00000	.72704+03	.11184+03
.0682	.40445-02	.78322+03	.14797-02	.14734+02	.56467-02	.32699+02	.00000	.00000	.72704+03	.11184+03
.0909	.41722-02	.79752+03	.15032-02	.27234+02	.55859-02	.48020+02	.00000	.00000	.71454+03	.10380+03
.1137	.42984-02	.81181+03	.15268-02	.39088+02	.55142-02	.63584+02	.00000	.00000	.70269+03	.95585+02
.1364	.44228-02	.82610+03	.15504-02	.50339+02	.54315-02	.79392+02	.00000	.00000	.69144+03	.87191+02
.1364	.44228-02	.82610+03	.15504-02	.50339+02	.54315-02	.79392+02	.00000	.00000	.69144+03	.87191+02
.1591	.45453-02	.84039+03	.15741-02	.61027+02	.53375-02	.95447+02	.00000	.00000	.68075+03	.78620+02
.1819	.46654-02	.85468+03	.15978-02	.71189+02	.52322-02	.11175+03	.00000	.00000	.67059+03	.69875+02
.2046	.47831-02	.86896+03	.16215-02	.80860+02	.51154-02	.12830+03	.00000	.00000	.66092+03	.60957+02
.2046	.47831-02	.86896+03	.16215-02	.80860+02	.51154-02	.12830+03	.00000	.00000	.66092+03	.60957+02
.2273	.48979-02	.88324+03	.16454-02	.90070+02	.49869-02	.14510+03	.00000	.00000	.65171+03	.51866+02
.2501	.50097-02	.89752+03	.16692-02	.98848+02	.48465-02	.16215+03	.00000	.00000	.64293+03	.42604+02
.2728	.51182-02	.91180+03	.16931-02	.10722+03	.46941-02	.17946+03	.00000	.00000	.63456+03	.33173+02
.2728	.51182-02	.91180+03	.16931-02	.10722+03	.46941-02	.17946+03	.00000	.00000	.63456+03	.33173+02
.2955	.52231-02	.92607+03	.17170-02	.11521+03	.45295-02	.19701+03	.00000	.00000	.62656+03	.23577+02
.3183	.53240-02	.94034+03	.17410-02	.12285+03	.43525-02	.21483+03	.00000	.00000	.61893+03	.13804+02
.3410	.54209-02	.95461+03	.17649-02	.13014+03	.41630-02	.23289+03	.00000	.00000	.61163+03	.38680+01
MAIN SHELL PART NO 5										
.0000	.54209-02	.95461+03	.17649-02	.13014+03	.41630-02	.23289+03	.00000	.00000	.63227+03	.12130+02
.0111	.54664-02	.96156+03	.17766-02	.13373+03	.40750-02	.24172+03	.00000	.00000	.62868+03	.71740+01
.0221	.55110-02	.96851+03	.17883-02	.13724+03	.39844-02	.25061+03	.00000	.00000	.62518+03	.21799+01
.0332	.55546-02	.97545+03	.18000-02	.14067+03	.38910-02	.25956+03	.00000	.00000	.62174+03	.28523+01
.0332	.55546-02	.97545+03	.18000-02	.14067+03	.38910-02	.25956+03	.00000	.00000	.62174+03	.28523+01
.0443	.55971-02	.98240+03	.18117-02	.14403+03	.37948-02	.26857+03	.00000	.00000	.61838+03	.79225+01
.0553	.56386-02	.98934+03	.18234-02	.14732+03	.36960-02	.27765+03	.00000	.00000	.61509+03	.13031+02
.0664	.56789-02	.99629+03	.18351-02	.15055+03	.35943-02	.28679+03	.00000	.00000	.61187+03	.18177+02
.0664	.56789-02	.99629+03	.18352-02	.15055+03	.35943-02	.28679+03	.00000	.00000	.61187+03	.18177+02
.0775	.57181-02	.10032+04	.18469-02	.15370+03	.34899-02	.29598+03	.00000	.00000	.60871+03	.23361+02
.0885	.57562-02	.10102+04	.18586-02	.15680+03	.33826-02	.30525+03	.00000	.00000	.60562+03	.28583+02
.0996	.57930-02	.10171+04	.18703-02	.15983+03	.32725-02	.31457+03	.00000	.00000	.60259+03	.33842+02
.0996	.57930-02	.10171+04	.18703-02	.15983+03	.32725-02	.31457+03	.00000	.00000	.60259+03	.33842+02
.1107	.58286-02	.10241+04	.18821-02	.16279+03	.31596-02	.32395+03	.00000	.00000	.59962+03	.39140+02
.1217	.58629-02	.10310+04	.18938-02	.16570+03	.30438-02	.33340+03	.00000	.00000	.59671+03	.44475+02
.1328	.58960-02	.10379+04	.19056-02	.16856+03	.29252-02	.34291+03	.00000	.00000	.59386+03	.49848+02



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.1328	-.58960-02	-.10379+04	.19056-02	.16856+03	.29252-02	-.34291+03	.00000	.00000	.59386+03	-.49848+02
.1439	-.59277-02	-.10449+04	.19174-02	.17135+03	.28036-02	-.35248+03	.00000	.00000	.59106+03	-.55259+02
.1549	-.59580-02	-.10518+04	.19291-02	.17409+03	.26791-02	-.36212+03	.00000	.00000	.58832+03	-.60707+02
.1660	-.59869-02	-.10588+04	.19409-02	.17678+03	.25517-02	-.37181+03	.00000	.00000	.58563+03	-.66193+02

MAIN SHELL PART NO 6

.0000	.19409-02	.17678+03	.59869-02	.10588+04	.25517-02	-.37181+03	.00000	.00000	.78076+03	-.11154+03
.0033	.19325-02	.17412+03	.59910-02	.10588+04	.24949-02	-.37123+03	.00000	.00000	.75127+03	-.11137+03
.0067	.19243-02	.17140+03	.59950-02	.10588+04	.24383-02	-.37065+03	.00000	.00000	.72244+03	-.11120+03
.0100	.19162-02	.16862+03	.59990-02	.10588+04	.23817-02	-.37009+03	.00000	.00000	.69428+03	-.11103+03
.0100	.19162-02	.16862+03	.59990-02	.10588+04	.23817-02	-.37013+03	.00000	.00000	.69430+03	-.11104+03
.0133	.19084-02	.16578+03	.60030-02	.10588+04	.23247-02	-.36957+03	.00000	.00000	.66680+03	-.11087+03
.0167	.19007-02	.16290+03	.60070-02	.10588+04	.22683-02	-.36902+03	.00000	.00000	.63997+03	-.11071+03
.0200	.18933-02	.15996+03	.60111-02	.10588+04	.22120-02	-.36848+03	.00000	.00000	.61379+03	-.11055+03
.0200	.18933-02	.15996+03	.60111-02	.10588+04	.22120-02	-.36848+03	.00000	.00000	.61378+03	-.11054+03
.0233	.18860-02	.15697+03	.60151-02	.10588+04	.21558-02	-.36795+03	.00000	.00000	.58825+03	-.11039+03
.0267	.18789-02	.15393+03	.60192-02	.10588+04	.20996-02	-.36744+03	.00000	.00000	.56339+03	-.11023+03
.0300	.18720-02	.15085+03	.60232-02	.10588+04	.20436-02	-.36693+03	.00000	.00000	.53918+03	-.11008+03
.0300	.18720-02	.15086+03	.60232-02	.10588+04	.20435-02	-.36693+03	.00000	.00000	.53917+03	-.11008+03
.0333	.18653-02	.14772+03	.60273-02	.10588+04	.19876-02	-.36643+03	.00000	.00000	.51562+03	-.10993+03
.0367	.18587-02	.14454+03	.60313-02	.10588+04	.19316-02	-.36594+03	.00000	.00000	.49272+03	-.10978+03
.0400	.18524-02	.14132+03	.60354-02	.10588+04	.18758-02	-.36547+03	.00000	.00000	.47047+03	-.10964+03
.0400	.18524-02	.14132+03	.60354-02	.10588+04	.18758-02	-.36547+03	.00000	.00000	.47047+03	-.10964+03
.0433	.18462-02	.13806+03	.60390-02	.10588+04	.18200-02	-.36500+03	.00000	.00000	.44888+03	-.10950+03
.0467	.18403-02	.13475+03	.60435-02	.10588+04	.17643-02	-.36455+03	.00000	.00000	.42793+03	-.10936+03
.0500	.18345-02	.13140+03	.60476-02	.10588+04	.17087-02	-.36410+03	.00000	.00000	.40764+03	-.10923+03

MAIN SHELL PART NO 7

.0000	.60476-02	.10588+04	-.18345-02	-.13140+03	.17087-02	-.36410+03	.00000	.00000	.73066+02	-.14823+03
.0184	.60174-02	.10473+04	-.18152-02	-.13366+03	.15603-02	-.34699+03	.00000	.00000	.75320+02	-.14010+03
.0369	.59900-02	.10357+04	-.17960-02	-.13599+03	.14188-02	-.33001+03	.00000	.00000	.77651+02	-.13210+03
.0553	.59650-02	.10241+04	-.17768-02	-.13840+03	.12842-02	-.31317+03	.00000	.00000	.80060+02	-.12425+03
.0553	.59650-02	.10241+04	-.17768-02	-.13840+03	.12842-02	-.31317+03	.00000	.00000	.80060+02	-.12425+03
.0738	.59425-02	.10126+04	-.17575-02	-.14089+03	.11565-02	-.29647+03	.00000	.00000	.82552+02	-.11653+03
.0922	.59223-02	.10010+04	-.17383-02	-.14347+03	.10356-02	-.27990+03	.00000	.00000	.85130+02	-.10896+03
.1107	.59043-02	.98942+03	-.17191-02	-.14614+03	.92144-03	-.26346+03	.00000	.00000	.87798+02	-.10153+03
.1107	.59043-02	.98942+03	-.17191-02	-.14614+03	.92144-03	-.26346+03	.00000	.00000	.87798+02	-.10153+03
.1291	.58883-02	.97784+03	-.16999-02	-.14890+03	.81405-03	-.24716+03	.00000	.00000	.90561+02	-.94255+02
.1476	.58742-02	.96627+03	-.16808-02	-.15176+03	.71334-03	-.23098+03	.00000	.00000	.93423+02	-.87124+02
.1660	.58620-02	.95469+03	-.16616-02	-.15473+03	.61929-03	-.21493+03	.00000	.00000	.96388+02	-.80144+02

MAIN SHELL PART NO 8

.0000	.58620-02	.95469+03	-.16616-02	-.15473+03	.61929-03	-.21493+03	.00000	.00000	.12495+03	-.91548+02
.0228	.58486-02	.94040+03	-.16378-02	-.15897+03	.55856-03	-.19511+03	.00000	.00000	.12920+03	-.83314+02
.0456	.58365-02	.92610+03	-.16141-02	-.16342+03	.50370-03	-.17546+03	.00000	.00000	.13364+03	-.75328+02
.0683	.58256-02	.91180+03	-.15904-02	-.16807+03	.45469-03	-.15598+03	.00000	.00000	.13829+03	-.67595+02
.0683	.58256-02	.91180+03	-.15904-02	-.16807+03	.45469-03	-.15598+03	.00000	.00000	.13829+03	-.67595+02
.0911	.58157-02	.89749+03	-.15667-02	-.17294+03	.41149-03	-.13667+03	.00000	.00000	.14317+03	-.60121+02
.1139	.58068-02	.88319+03	-.15430-02	-.17805+03	.37408-03	-.11751+03	.00000	.00000	.14828+03	-.52915+02
.1367	.57986-02	.86888+03	-.15190-02	-.18342+03	.34243-03	-.98501+02	.00000	.00000	.15364+03	-.45982+02



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MAIN SHELL PART NO 9

.1367	.57986-02	.86888+03	-.15194-02	-.18342+03	.34243-03	-.98501+02	.00000	.00000	.15364+03	-.45982+02
.1594	.57911-02	.85457+03	-.14957-02	-.18905+03	.31652-03	-.79636+02	.00000	.00000	.15927+03	-.39331+02
.1822	.57842-02	.84026+03	-.14721-02	-.19497+03	.29634-03	-.60904+02	.00000	.00000	.16519+03	-.32970+02
.2050	.57776-02	.82594+03	-.14485-02	-.20119+03	.28186-03	-.42295+02	.00000	.00000	.17142+03	-.26909+02

.0000	.14485-02	.20119+03	.57776-02	.82594+03	.28186-03	-.42296+02	.00000	.00000	.29221+03	-.13144+02
.0740	.15823-02	.12909+03	.58475-02	.82594+03	-.36128-02	-.30178+02	.00000	.00000	.46473+03	-.11277+02
.1479	.19496-02	.72660+02	.59273-02	.82594+03	-.61634-02	-.22892+02	.00000	.00000	.83658+03	-.13666+02
.2219	.24803-02	.34130+02	.60144-02	.82594+03	-.80963-02	-.19036+02	.00000	.00000	.11065+04	-.19221+02

.2219	.24800-02	.34154+02	.60144-02	.82594+03	-.80928-02	-.19033+02	.00000	.00000	.11062+04	-.19215+02
.2958	.31278-02	.10332+02	.61184-02	.82594+03	-.92391-02	-.17470+02	.00000	.00000	.13448+04	-.27092+02
.3698	.38007-02	-.39853+01	.62746-02	.82594+03	-.84308-02	-.17264+02	.00000	.00000	.14260+04	-.33580+02
.4437	.43168-02	-.11693+02	.64928-02	.82594+03	-.56019-02	-.17911+02	.00000	.00000	.16150+04	-.38734+02

.4437	.43143-02	-.11828+02	.64931-02	.82594+03	-.55940-02	-.17919+02	.00000	.00000	.16134+04	-.38696+02
.5177	.46492-02	-.11433+02	.66969-02	.82594+03	-.36262-02	-.18811+02	.00000	.00000	.17076+04	-.41262+02
.5917	.48733-02	-.79993+01	.68874-02	.82594+03	-.25681-02	-.19537+02	.00000	.00000	.17299+04	-.42025+02
.6656	.50452-02	-.44075+01	.70723-02	.82594+03	-.21624-02	-.19992+02	.00000	.00000	.17185+04	-.41883+02

.6656	.50458-02	-.43668+01	.70722-02	.82594+03	-.21634-02	-.19988+02	.00000	.00000	.17189+04	-.41892+02
.7396	.52027-02	-.17321+01	.72590-02	.82594+03	-.21194-02	-.20206+02	.00000	.00000	.16980+04	-.41446+02
.8135	.53629-02	-.23435-00	.74529-02	.82594+03	-.22250-02	-.20273+02	.00000	.00000	.16792+04	-.41009+02
.8875	.55325-02	.78401-00	.76568-02	.82594+03	-.23382-02	-.20263+02	.00000	.00000	.16665+04	-.40697+02

.8875	.55336-02	.39857-00	.76566-02	.82594+03	-.23673-02	-.20265+02	.00000	.00000	.16672+04	-.40714+02
.9615	.57129-02	.52810-00	.78717-02	.82594+03	-.24733-02	-.20229+02	.00000	.00000	.16607+04	-.40545+02
1.0354	.58984-02	.41680-00	.80983-02	.82594+03	-.25373-02	-.20193+02	.00000	.00000	.16583+04	-.40473+02
1.1094	.60873-02	.23362-00	.83360-02	.82594+03	-.25672-02	-.20169+02	.00000	.00000	.16579+04	-.40457+02

1.1094	.60882-02	.26106-00	.83359-02	.82594+03	-.25728-02	-.20168+02	.00000	.00000	.16585+04	-.40471+02
1.1833	.62789-02	.12549-00	.85844-02	.82594+03	-.25813-02	-.20154+02	.00000	.00000	.16592+04	-.40485+02
1.2573	.64498-02	.35628-01	.88434-02	.82594+03	-.25789-02	-.20149+02	.00000	.00000	.16600+04	-.40504+02
1.3312	.66603-02	-.14370-01	.91128-02	.82594+03	-.25733-02	-.20148+02	.00000	.00000	.16606+04	-.40518+02

1.3312	.66601-02	-.40741-02	.91129-02	.82594+03	-.25698-02	-.20146+02	.00000	.00000	.16605+04	-.40514+02
1.4052	.68499-02	-.41833-01	.93927-02	.82594+03	-.25619-02	-.20147+02	.00000	.00000	.16606+04	-.40516+02
1.4792	.70392-02	-.84549-01	.96826-02	.82594+03	-.25577-02	-.20152+02	.00000	.00000	.16603+04	-.40512+02
1.5531	.72284-02	-.14354-00	.99827-02	.82594+03	-.25606-02	-.20160+02	.00000	.00000	.16601+04	-.40507+02

1.5531	.72284-02	-.11183+00	.99828-02	.82594+03	-.25558-02	-.20155+02	.00000	.00000	.16600+04	-.40506+02
1.6271	.74176-02	-.18907-00	.10293-01	.82594+03	-.25638-02	-.20166+02	.00000	.00000	.16597+04	-.40502+02
1.7010	.76080-02	-.26717-00	.10613-01	.82594+03	-.25879-02	-.20183+02	.00000	.00000	.16601+04	-.40516+02
1.7750	.78010-02	-.28452-00	.10943-01	.82594+03	-.26344-02	-.20204+02	.00000	.00000	.16621+04	-.40570+02

1.7750	.78009-02	-.25558-00	.10943-01	.82594+03	-.26293-02	-.20199+02	.00000	.00000	.16620+04	-.40568+02
1.8490	.79976-02	-.10717+00	.11283-01	.82594+03	-.26921-02	-.20214+02	.00000	.00000	.16663+04	-.40675+02
1.9229	.81993-02	.22617-00	.11633-01	.82594+03	-.27620-02	-.20209+02	.00000	.00000	.16659+04	-.40664+02
1.9969	.84057-02	.41324-00	.11995-01	.82594+03	-.28146-02	-.20185+02	.00000	.00000	.16636+04	-.40607+02

1.9969	.84056-02	.44159-00	.11995-01	.82594+03	-.28088-02	-.20179+02	.00000	.00000	.16635+04	-.40598+02
2.0708	.86139-02	.52148-00	.12369-01	.82594+03	-.28189-02	-.20143+02	.00000	.00000	.16618+04	-.40545+02
2.1448	.88215-02	.49185-00	.12785-01	.82594+03	-.27871-02	-.20105+02	.00000	.00000	.16606+04	-.40478+02
2.2187	.90265-02	.50761-00	.13154-01	.82594+03	-.27616-02	-.20069+02	.00000	.00000	.16621+04	-.40406+02

2.2187	.90268-02	.52126-00	.13154-01	.82594+03	-.27633-02	-.20068+02	.00000	.00000	.16624+04	-.40411+02
2.2927	.92309-02	.59383-00	.13563-01	.82594+03	-.27591-02	-.20027+02	.00000	.00000	.16626+04	-.40308+02

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2.3667	.94353-02	.66134-00	.13983-01	.82594+03	-.27705-02	-.19980+02	.00000	.00000	.16623+04	-.40184+02
2.4406	.96410-02	.71056-00	.14414-01	.82594+03	-.27917-02	-.19929+02	.00000	.00000	.16620+04	-.40065+02
2.4406	.96408-02	.74379-00	.14414-01	.82594+03	-.27854-02	-.19923+02	.00000	.00000	.16619+04	-.40061+02
2.5146	.98475-02	.76982-00	.14857-01	.82594+03	-.28041-02	-.19867+02	.00000	.00000	.16615+04	-.39936+02
2.5885	.10056-01	.77859-00	.15312-01	.82594+03	-.28234-02	-.19810+02	.00000	.00000	.16613+04	-.39815+02
2.6625	.10265-01	.77792-00	.15778-01	.82594+03	-.28424-02	-.19752+02	.00000	.00000	.16612+04	-.39697+02
2.6625	.10265-01	.79222-00	.15778-01	.82594+03	-.28425-02	-.19750+02	.00000	.00000	.16613+04	-.39699+02
2.7365	.10474-01	.79480-00	.16257-01	.82594+03	-.28592-02	-.19692+02	.00000	.00000	.16613+04	-.39582+02
2.8104	.10688-01	.79648-00	.16747-01	.82594+03	-.28745-02	-.19633+02	.00000	.00000	.16613+04	-.39465+02
2.8844	.10901-01	.79497-00	.17249-01	.82594+03	-.28882-02	-.19574+02	.00000	.00000	.16612+04	-.39347+02
2.8844	.10901-01	.82234-00	.17249-01	.82594+03	-.28845-02	-.19570+02	.00000	.00000	.16612+04	-.39345+02
2.9583	.11115-01	.80438-00	.17764-01	.82594+03	-.28913-02	-.19509+02	.00000	.00000	.16606+04	-.39216+02
3.0323	.11329-01	.74377-00	.18290-01	.82594+03	-.28963-02	-.19452+02	.00000	.00000	.16594+04	-.39076+02
3.1062	.11543-01	.61310-00	.18829-01	.82594+03	-.29043-02	-.19401+02	.00000	.00000	.16581+04	-.38928+02
3.1062	.11544-01	.62361-00	.18829-01	.82594+03	-.29064-02	-.19401+02	.00000	.00000	.16583+04	-.38933+02
3.1802	.11759-01	.41808-00	.19380-01	.82594+03	-.29265-02	-.19362+02	.00000	.00000	.16568+04	-.38787+02
3.2542	.11977-01	.14225-00	.19942-01	.82594+03	-.29737-02	-.19341+02	.00000	.00000	.16560+04	-.38664+02
3.3281	.12200-01	-.12049+00	.20515-01	.82594+03	-.30673-02	-.19340+02	.00000	.00000	.16574+04	-.38603+02
3.3281	.12200-01	-.84427-01	.20515-01	.82594+03	-.30603-02	-.19334+02	.00000	.00000	.16575+04	-.38598+02
3.4021	.12431-01	-.15308-00	.21100-01	.82594+03	-.32093-02	-.19344+02	.00000	.00000	.16636+04	-.38644+02
3.4760	.12676-01	.31494-00	.21695-01	.82594+03	-.34210-02	-.19343+02	.00000	.00000	.16773+04	-.38861+02
3.5500	.12938-01	.18129+01	.22302-01	.82594+03	-.36577-02	-.19273+02	.00000	.00000	.17008+04	-.39283+02
3.5500	.12938-01	.18311+01	.22302-01	.82594+03	-.36566-02	-.19270+02	.00000	.00000	.17009+04	-.39284+02
3.6240	.13215-01	.49033+01	.22923-01	.82594+03	-.38056-02	-.19032+02	.00000	.00000	.17331+04	-.39852+02
3.6979	.13494-01	.97877+01	.23567-01	.82594+03	-.36531-02	-.18499+02	.00000	.00000	.17636+04	-.40289+02
3.7719	.13740-01	.15923+02	.24228-01	.82594+03	-.28670-02	-.17552+02	.00000	.00000	.17733+04	-.40118+02
3.7719	.13741-01	.15919+02	.24228-01	.82594+03	-.28721-02	-.17559+02	.00000	.00000	.17735+04	-.40126+02
3.8458	.13893-01	.21189+02	.24930-01	.82594+03	-.10530-02	-.16166+02	.00000	.00000	.17244+04	-.38482+02
3.9198	.13876-01	.24916+02	.25654-01	.82594+03	.11894-02	-.14498+02	.00000	.00000	.18021+04	-.35184+02
3.9937	.13767-01	.35382+02	.26340-01	.82594+03	.16144-02	-.12292+02	.00000	.00000	.18715+04	-.28093+02
3.9937	.13787-01	.36559+02	.26335-01	.82594+03	.14708-02	-.12212+02	.00000	.00000	.18896+04	-.28343+02
4.0677	.13679-01	.48411+02	.27023-01	.82594+03	.14175-02	-.90527+01	.00000	.00000	.18388+04	-.18982+02
4.1417	.13578-01	.53929+02	.27722-01	.82594+03	.13324-02	-.52029+01	.00000	.00000	.18263+04	-.10521+02
4.2156	.13473-01	.40382+02	.28441-01	.82594+03	.15770-02	-.15714+01	.00000	.00000	.12061+04	-.67008+01
4.2156	.13472-01	.40004+02	.28441-01	.82594+03	.15846-02	-.16094+01	.00000	.00000	.12048+04	-.67033+01
4.2896	.13334-01	.21342+01	.29182-01	.82594+03	.21617-02	.10530+00	.00000	.00000	.74861+03	-.32238+01
4.3635	.13152-01	.162551+02	.29943-01	.82594+03	.27407-02	-.19547+01	.00000	.00000	.24114+03	-.54325+00
4.4375	.12943-01	.15647+03	.30720-01	.82594+03	.27445-02	-.98701+01	.00000	.00000	-.29333+03	.55622+00
MAIN SHELL PART NO 10										
1.5708	.12943-01	-.15643+03	.30720-01	.82595+03	.27452-02	-.98649+01	.00000	.00000	-.29337+03	.55804+00
1.6134	.14206-01	-.14086+03	.30283-01	.83252+03	.26271-02	-.11837+02	.00000	.00000	-.33335+03	.19223+00
1.6559	.15450-01	-.12553+03	.29793-01	.83894+03	.24691-02	-.13616+02	.00000	.00000	-.37201+03	-.11921+00
1.6559	.15450-01	-.12553+03	.29793-01	.83894+03	.24691-02	-.13616+02	.00000	.00000	-.37201+03	-.11924+00
1.6985	.16675-01	-.11051+03	.29251-01	.84529+03	.22740-02	-.15215+02	.00000	.00000	-.40889+03	-.38014+00
1.7410	.17878-01	-.95860+02	.28660-01	.85162+03	.20441-02	-.16639+02	.00000	.00000	-.44354+03	-.59400+00
1.7410	.17878-01	-.95861+02	.28660-01	.85162+03	.20441-02	-.16639+02	.00000	.00000	-.44356+03	-.59400+00
1.7836	.19058-01	-.81636+02	.28020-01	.85801+03	.17812-02	-.17897+02	.00000	.00000	-.47554+03	-.76400+00



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1.8262	.20213-01	-.67892+02	.27333-01	.86455+03	.14868-02	-.18995+02	.00000	.00000	-.50438+03	-.89316-00
1.8262	.20213-01	-.67893+02	.27333-01	.86455+03	.14867-02	-.18995+02	.00000	.00000	-.50438+03	-.89317-00
1.8687	.21342-01	-.84686+02	.26602-01	.87131+03	.11617-02	-.19936+02	.00000	.00000	-.52958+03	-.98440-00
1.9113	.22443-01	-.42070+02	.25828-01	.87841+03	.80692-03	-.20724+02	.00000	.00000	-.55053+03	-.10408+01
1.9113	.22443-01	-.42070+02	.25828-01	.87841+03	.80689-03	-.20724+02	.00000	.00000	-.55052+03	-.10408+01
1.9538	.23515-01	-.30096+02	.25012-01	.88596+03	.42293-03	-.21362+02	.00000	.00000	-.56666+03	-.10654+01
1.9964	.24559-01	-.18811+02	.24159-01	.89408+03	.10263-04	-.21851+02	.00000	.00000	-.57727+03	-.10615+01
1.9964	.24559-01	-.18812+02	.24159-01	.89408+03	.10234-04	-.21851+02	.00000	.00000	-.57727+03	-.10615+01
2.0390	.25571-01	-.82615+01	.23268-01	.90289+03	-.43074-03	-.22193+02	.00000	.00000	-.58155+03	-.10330+01
2.0815	.26554-01	.15167+01	.22344-01	.91255+03	-.89959-03	-.22386+02	.00000	.00000	-.57858+03	-.98407-00
2.0815	.26554-01	.15156+01	.22344-01	.91255+03	-.89964-03	-.22386+02	.00000	.00000	-.57858+03	-.98404-00
2.1241	.27506-01	.10491+02	.21389-01	.92319+03	-.13958-02	-.22430+02	.00000	.00000	-.56733+03	-.91957-00
2.1666	.28427-01	.18646+02	.20405-01	.93497+03	-.19184-02	-.22324+02	.00000	.00000	-.54656+03	-.84529-00
2.1666	.28427-01	.18644+02	.20405-01	.93497+03	-.19185-02	-.22324+02	.00000	.00000	-.54656+03	-.84525-00
2.2092	.29320-01	.25974+02	.19395-01	.94803+03	-.74664-02	-.22064+02	.00000	.00000	-.51488+03	-.76780-00
2.2518	.30184-01	.32498+02	.18362-01	.96251+03	-.30375-02	-.21648+02	.00000	.00000	-.47069+03	-.69489-00
2.2518	.30184-01	.32495+02	.18362-01	.96252+03	-.30376-02	-.21647+02	.00000	.00000	-.47069+03	-.69480-00
2.2943	.31022-01	.38257+02	.17310-01	.97852+03	-.36292-02	-.21067+02	.00000	.00000	-.41212+03	-.63536-00
2.3369	.31836-01	.43340+02	.16242-01	.99611+03	-.42369-02	-.20314+02	.00000	.00000	-.33707+03	-.59941-00
2.3369	.31836-01	.43333+02	.16242-01	.99612+03	-.42371-02	-.20314+02	.00000	.00000	-.33708+03	-.59921-00
2.3794	.32629-01	.47869+02	.15161-01	.10153+04	-.48546-02	-.19374+02	.00000	.00000	-.24315+03	-.59790-00
2.4220	.33405-01	.52056+02	.14072-01	.10358+04	-.54725-02	-.18226+02	.00000	.00000	-.12767+03	-.64281-00
2.4220	.33405-01	.52043+02	.14072-01	.10358+04	-.54728-02	-.18226+02	.00000	.00000	-.12769+03	-.64242-00
2.4646	.34168-01	.56159+02	.12979-01	.10573+04	-.60775-02	-.16835+02	.00000	.00000	-.12248+02	-.74506-00
2.5071	.34923-01	.60592+02	.11886-01	.10792+04	-.66486-02	-.15145+02	.00000	.00000	-.17971+03	-.91478-00
2.5071	.34923-01	.60563+02	.11886-01	.10792+04	-.66492-02	-.15145+02	.00000	.00000	-.17964+03	-.91391-00
2.5497	.35674-01	.65829+02	.10797-01	.11001+04	-.71558-02	-.13069+02	.00000	.00000	-.37764+03	-.11562+01
2.5922	.36426-01	.72603+02	.97173-02	.11181+04	-.75508-02	-.10467+02	.00000	.00000	-.60866+03	-.14673+01
2.5922	.36426-01	.72538+02	.97174-02	.11182+04	-.75519-02	-.10467+02	.00000	.00000	-.60845+03	-.14653+01
2.6348	.37180-01	.81661+02	.86526-02	.11302+04	-.77614-02	-.71204+01	.00000	.00000	-.87366+03	-.18289+01
2.6774	.37930-01	.94140+02	.76081-02	.11316+04	-.76682-02	-.26824+01	.00000	.00000	-.11712+04	-.22049+01
2.6774	.37930-01	.93991+02	.76084-02	.11319+04	-.76704-02	-.26843+01	.00000	.00000	-.11708+04	-.21999+01
2.7199	.38660-01	.11089+03	.65906-02	.11158+04	-.70857-02	.33622+01	.00000	.00000	-.14927+04	-.25229+01
2.7625	.39332-01	.13314+03	.56072-02	.10725+04	-.57027-02	.11814+02	.00000	.00000	-.18197+04	-.26909+01
2.7625	.39331-01	.13279+03	.56079-02	.10734+04	-.57074-02	.11805+02	.00000	.00000	-.18180+04	-.26777+01
2.8050	.39866-01	.16055+03	.46696-02	.99077+03	-.30288-02	.23780+02	.00000	.00000	-.21079+04	-.25856+01
2.8476	.40110-01	.19216+03	.37922-02	.85542+03	-.17511-02	.40904+02	.00000	.00000	-.22762+04	-.21837+01
MAIN SHELL PART NO 11										
.0000	.20483-01	-.58216+03	.34689-01	.65878+03	.17417-02	.40871+02	.00000	.00000	.44542+04	.50312+02
.0529	.20384-01	-.36771+03	.35210-01	.57273+03	.19695-02	.15615+02	.00000	.00000	.36912+04	.30227+02
.0529	.20384-01	-.36771+03	.35210-01	.57273+03	.19695-02	.15615+02	.00000	.00000	.36912+04	.30227+02
.1058	.20277-01	-.19660+03	.35735-01	.50170+03	.20258-02	.48260-00	.00000	.00000	.29569+04	.16076+02
.1058	.20277-01	-.19661+03	.35735-01	.50171+03	.20258-02	.48251-00	.00000	.00000	.29569+04	.16076+02
.1588	.20172-01	-.68310+02	.36263-01	.44550+03	.19004-02	-.67342+01	.00000	.00000	.22967+04	.70259+01



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.1588	.20172-01	-.68323+02	.36263-01	.44550+03	.19003-02	-.67344+01	.00000	.00000	.22966+04	.70257+01
.2117	.20079-01	-.20860+02	.36793-01	.40285+03	.15958-02	-.81547+01	.00000	.00000	.17424+04	.20143+01
.2117	.20079-01	.20854+02	.36793-01	.40285+03	.15958-02	-.81548+01	.00000	.00000	.17424+04	.20143+01
.2646	.20006-01	.76859+02	.37325-01	.37168+03	.11601-02	-.56570+01	.00000	.00000	.13066+04	-.10407+00
.2646	.20006-01	.76851+02	.37325-01	.37168+03	.11601-02	-.56572+01	.00000	.00000	.13066+04	-.10409+00
.3175	.19955-01	.10620+03	.37860-01	.34973+03	.81215-03	-.79387-00	.00000	.00000	.97201+03	-.37988-00

MAIN SHELL PART NO 12

.0000	.64536-02	-.14217+02	.42308-01	.36522+03	.81220-03	-.79396-00	.00000	.00000	.92846+03	-.23819-00
.0739	.64030-02	.70096-00	.43059-01	.36522+03	.53916-03	-.12139+01	.00000	.00000	.82380+03	-.36417-00
.1478	.63738-02	.54675+01	.43811-01	.36522+03	.26345-03	-.94035-00	.00000	.00000	.76330+03	-.28210-00
.2217	.63617-02	.51251+01	.44564-01	.36522+03	.80753-04	-.53027-00	.00000	.00000	.73829+03	-.15908-00
.2217	.63617-02	.51265+01	.44564-01	.36522+03	.80649-04	-.53027-00	.00000	.00000	.73829+03	-.15908-00
.2956	.63596-02	.31205+01	.45318-01	.36522+03	-.10058-04	-.22233-00	.00000	.00000	.73387+03	-.66700-01
.3694	.63618-02	.12135+01	.46071-01	.36522+03	-.43022-04	-.65740-01	.00000	.00000	.73843+03	-.19722-01
.4433	.63654-02	.79816-01	.46824-01	.36522+03	-.52415-04	-.23604-01	.00000	.00000	.74586+03	-.70811-02
.4433	.63642-02	.19812-00	.46824-01	.36522+03	-.34559-04	.27508-01	.00000	.00000	.74347+03	.82523-02
.5172	.63665-02	-.45534-00	.47577-01	.36522+03	-.28335-04	.14403-01	.00000	.00000	.74824+03	.43210-02
.5911	.63686-02	-.56323-00	.48331-01	.36522+03	-.29672-04	-.26467-01	.00000	.00000	.75254+03	-.79400-02
.6650	.63712-02	-.97288-01	.49084-01	.36522+03	-.40519-04	-.54852-01	.00000	.00000	.75762+03	-.16456-01
.6650	.63718-02	-.20288-00	.49084-01	.36522+03	-.51557-04	-.88834-01	.00000	.00000	.75921+03	-.26650-01
.7389	.63764-02	.13298+01	.49836-01	.36522+03	-.71758-04	-.54437-01	.00000	.00000	.76875+03	-.16331-01
.8128	.63818-02	.41724+01	.50589-01	.36522+03	-.65417-04	.14034-00	.00000	.00000	.77986+03	.42102-01
.8867	.63842-02	.81239+01	.51342-01	.36522+03	.19596-04	.59068-00	.00000	.00000	.78479+03	.17720-00
.8867	.63847-02	.80383+01	.51342-01	.36522+03	.10607-04	.56300-00	.00000	.00000	.78593+03	.16890-00
.9606	.63767-02	.11634+02	.52094-01	.36522+03	.23740-03	.13020+01	.00000	.00000	.76931+03	.39060-00
1.0344	.63445-02	.10431+02	.52848-01	.36522+03	.67159-03	.21675+01	.00000	.00000	.70255+03	.65024-00
1.1083	.62730-02	-.36956+01	.53603-01	.36522+03	.12784-02	.25283+01	.00000	.00000	.55458+03	.75848-00
1.1083	.62736-02	-.37915+01	.53603-01	.36522+03	.12682-02	.24971+01	.00000	.00000	.55587+03	.74913-00
1.1822	.61594-02	-.41561+02	.54361-01	.36522+03	.17621-02	.10012+01	.00000	.00000	.31939+03	.30036-00
1.2561	.60328-02	-.11125+03	.55125-01	.36522+03	.14401-02	-.44440+01	.00000	.00000	.57207+02	-.13332+01
1.3300	.59976-02	-.20481+03	.55891-01	.36522+03	-.97125-03	-.16062+02	.00000	.00000	-.15582+02	-.48185+01

MAIN SHELL PART NO 13

.0000	.53882-01	.25798+03	.16017-01	.32985+03	-.98000-03	-.16087+02	.00000	.00000	-.14399+03	-.17670+01
.0484	.53936-01	.21138+03	.16512-01	.36680+03	-.12116-02	-.56230+01	.00000	.00000	-.11068+03	.37515+01
.0484	.53936-01	.21138+03	.16512-01	.36680+03	-.12116-02	-.56231+01	.00000	.00000	-.11067+03	.37515+01
.0968	.53996-01	.16376+03	.17007-01	.40580+03	-.12631-02	.28290+01	.00000	.00000	-.44167+02	.88517+01
.0968	.53996-01	.16376+03	.17007-01	.40580+03	-.12631-02	.28291+01	.00000	.00000	-.44162+02	.88515+01
.1452	.54057-01	.11609+03	.17502-01	.44445+03	-.12301-02	.91378+01	.00000	.00000	-.52757+02	.13599+02
.1452	.54057-01	.11608+03	.17502-01	.44446+03	-.12300-02	.91386+01	.00000	.00000	.52733+02	.13598+02
.1936	.54115-01	.69706+02	.17996-01	.47937+03	-.11666-02	.13170+02	.00000	.00000	.18192+03	.18171+02
.1936	.54115-01	.69698+02	.17996-01	.47939+03	-.11665-02	.13171+02	.00000	.00000	.18189+03	.18170+02
.2420	.54170-01	.26838+02	.18490-01	.50501+03	-.11037-02	.14776+02	.00000	.00000	.35153+03	.22937+02
.2420	.54170-01	.26828+02	.18490-01	.50503+03	-.11036-02	.14779+02	.00000	.00000	.35150+03	.22935+02

.2905	.54222-01	-.83790+01	.18983-01	.51112+03	-.10597-02	.13770+02	.00000	.00000	.5798+03	.28584+02
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MAIN SHELL PART NO 14

.0000	.57349-01	.18935+03	-.33930-02	.47487+03	-.10595-02	.13774+02	.00000	.00000	.56901+03	.30632+02
.0233	.57373-01	.17338+03	-.31563-02	.46752+03	-.10434-02	.16800+02	.00000	.00000	.57636+03	.33100+02
.0466	.57397-01	.15718+03	-.29198-02	.45830+03	-.10215-02	.19386+02	.00000	.00000	.58557+03	.35521+02
.0466	.57397-01	.15718+03	-.29198-02	.45830+03	-.10215-02	.19387+02	.00000	.00000	.58557+03	.35520+02
.0699	.57421-01	.14068+03	-.26832-02	.44653+03	-.99501-03	.21478+02	.00000	.00000	.59734+03	.37941+02
.0932	.57444-01	.12381+03	-.24468-02	.43117+03	-.96554-03	.22994+02	.00000	.00000	.61271+03	.40432+02
.0932	.57444-01	.12381+03	-.24468-02	.43117+03	-.96554-03	.22994+02	.00000	.00000	.61271+03	.40432+02
.1165	.57466-01	.10644+03	-.22106-02	.41058+03	-.93493-03	.23807+02	.00000	.00000	.63330+03	.43108+02
.1398	.57487-01	.88399+02	-.19745-02	.38210+03	-.90564-03	.23713+02	.00000	.00000	.66178+03	.46154+02
.1398	.57487-01	.88399+02	-.19745-02	.38211+03	-.90565-03	.23712+02	.00000	.00000	.66180+03	.46155+02
.1631	.57508-01	.69400+02	-.17387-02	.34113+03	-.88109-03	.22360+02	.00000	.00000	.70279+03	.49899+02
.1864	.57528-01	.48991+02	-.15033-02	.27908+03	-.86641-03	.19104+02	.00000	.00000	.76484+03	.54953+02
.1864	.57528-01	.48991+02	-.15033-02	.27909+03	-.86643-03	.19102+02	.00000	.00000	.76487+03	.54954+02
.2097	.57548-01	.26372+02	-.12685-02	.17862+03	-.87012-03	.12639+02	.00000	.00000	.86533+03	.62565+02
.2330	.57569-01	.93919+03	-.10347-02	.27715+01	-.90783-03	.42787+02	.00000	.00000	.10440+04	.75611+02

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KALNINS SHELL STRESS ANALYSIS..... HOT END PRESSURE SHELL MORIMOTO JUN 73

DEFLECTIONS AND STRESSES FOR WAVE NUMBER NX= 0

1250 PSI PLUS TEMPERATURE LOADING

X	W	UPHI	UTHETA	BPFI	SPHI IN	SPHI OUT	STHETA IN	STHETA OUT	SFITH IN	SFITH OUT
MAIN SHELL PART NO 1										
.0000	.00000	.00000	.00000	.00000	.10062+06	-.77490+05	-.15199+04	-.54954+05	.00000	.00000
.0250	.25354-04	.61185-04	.00000	-.19802-02	.86579+05	-.62736+05	-.51002+04	-.49895+05	.00000	.00000
.0500	.96600-04	.11853-03	.00000	-.36714-02	.73301+05	-.48707+05	-.73038+04	-.43906+05	.00000	.00000
.0500	.96601-04	.11853-03	.00000	-.36714-02	.73301+05	-.48707+05	-.73038+04	-.43906+05	.00000	.00000
.0750	.20653-03	.17174-03	.00000	-.50757-02	.60882+05	-.35485+05	-.82836+04	-.37194+05	.00000	.00000
.1000	.34803-03	.22139-03	.00000	-.61968-02	.49375+05	-.23123+05	-.82014+04	-.29951+05	.00000	.00000
.1000	.34803-03	.22139-03	.00000	-.61969-02	.49374+05	-.23122+05	-.82016+04	-.29951+05	.00000	.00000
.1250	.51406-03	.26790-03	.00000	-.70403-02	.38802+05	-.11635+05	-.72258+04	-.22357+05	.00000	.00000
.1500	.69778-03	.31170-03	.00000	-.76120-02	.29155+05	-.10066+04	-.55308+04	-.14579+05	.00000	.00000
.1500	.69778-03	.31170-03	.00000	-.76120-02	.29154+05	-.10058+04	-.55311+04	-.14579+05	.00000	.00000
.1750	.89245-03	.35326-03	.00000	-.79177-02	.20396+05	.88071+04	-.32958+04	-.67726+04	.00000	.00000
.2000	.10915-02	.39310-03	.00000	-.79624-02	.12466+05	.17874+05	-.70301+03	.91949+03	.00000	.00000
.2000	.10915-02	.39310-03	.00000	-.79624-02	.12465+05	.17875+05	-.70331+03	.91961+03	.00000	.00000
.2250	.12884-02	.43172-03	.00000	-.77491-02	.92834+04	.26286+05	.20613+04	.83621+04	.00000	.00000
.2500	.14768-02	.46970-03	.00000	-.72783-02	-.12425+04	.34145+05	.48091+04	.15425+05	.00000	.00000
MAIN SHELL PART NO 2										
.0000	.14768-02	.46970-03	.00000	-.72783-02	-.12431+04	.34146+05	.48087+04	.15425+05	.00000	.00000
.2241	.24194-02	.77614-03	.00000	-.14773-02	.33663+04	.29536+05	.29736+05	.37587+05	.00000	.00000
.4482	.24771-02	.10589-02	.00000	.34373-03	.15482+05	.17421+05	.34812+05	.35394+05	.00000	.00000
.4482	.24792-02	.10588-02	.00000	.33038-03	.15498+05	.17404+05	.34870+05	.35442+05	.00000	.00000
.6723	.24116-02	.13438-02	.00000	.18790-03	.17336+05	.15567+05	.33733+05	.33202+05	.00000	.00000
.8964	.23923-02	.16312-02	.00000	.19940-04	.16677+05	.16226+05	.33053+05	.32918+05	.00000	.00000
.8964	.23946-02	.16311-02	.00000	.54886-05	.16693+05	.16210+05	.33116+05	.32971+05	.00000	.00000
1.1205	.23965-02	.19187-02	.00000	-.51184-05	.16351+05	.16551+05	.33060+05	.33120+05	.00000	.00000
1.3446	.23933-02	.22062-02	.00000	.33714-04	.16358+05	.16545+05	.32982+05	.33038+05	.00000	.00000
1.3446	.23961-02	.22062-02	.00000	.15842-04	.16378+05	.16525+05	.33059+05	.33103+05	.00000	.00000
1.5687	.23925-02	.24938-02	.00000	-.11113-05	.16740+05	.16163+05	.33077+05	.32903+05	.00000	.00000
1.7928	.24127-02	.27812-02	.00000	-.22955-03	.17687+05	.15216+05	.33866+05	.33124+05	.00000	.00000
1.7928	.24150-02	.27812-02	.00000	-.24419-03	.17703+05	.15199+05	.33929+05	.33178+05	.00000	.00000
2.0169	.25073-02	.30653-02	.00000	-.47277-03	.15378+05	.17524+05	.35537+05	.36180+05	.00000	.00000
2.2410	.24422-02	.33460-02	.00000	.18869-02	-.95885+03	.33861+05	.29008+05	.39454+05	.00000	.00000
MAIN SHELL PART NO 3										
.0000	.24450-02	.33460-02	.00000	.18690-02	-.93866+03	.33841+05	.29086+05	.39520+05	.00000	.00000
.0250	.23911-02	.33774-02	.00000	.34338-02	-.83375+03	.32403+05	.27771+05	.37742+05	.00000	.00000
.0500	.23237-02	.34082-02	.00000	.29536-02	-.79907+03	.31140+05	.26097+05	.35679+05	.00000	.00000
.0500	.23237-02	.34082-02	.00000	.29536-02	-.79908+03	.31140+05	.26097+05	.35679+05	.00000	.00000
.0750	.22438-02	.34386-02	.00000	.34348-02	-.78456+03	.29988+05	.24105+05	.33337+05	.00000	.00000
.1000	.21523-02	.34689-02	.00000	.38812-02	-.72797+03	.28877+05	.21836+05	.30717+05	.00000	.00000
.1000	.21523-02	.34689-02	.00000	.38813-02	-.72824+03	.28877+05	.21836+05	.30717+05	.00000	.00000

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.1250	.20500-02	.34990-02	.00000	.42943-02	.56027+03	.27727+05	.19332+05	.27618+05	.00000	.00000
.1500	.19378-02	.35293-02	.00000	.46731-02	.20496+03	.26459+05	.16636+05	.24635+05	.00000	.00000

.1500	.19378-02	.35293-02	.00000	.46732-02	.20712+03	.26459+05	.16636+05	.24635+05	.00000	.00000
.1750	.18166-02	.35598-02	.00000	.50150-02	.40649+03	.24990+05	.13793+05	.21168+05	.00000	.00000
.2000	.16874-02	.35908-02	.00000	.53152-02	.13555+04	.23239+05	.10849+05	.17415+05	.00000	.00000

.2000	.16874-02	.35908-02	.00000	.53153-02	.13556+04	.23239+05	.10850+05	.17415+05	.00000	.00000
.2250	.15513-02	.36224-02	.00000	.55678-02	.27131+04	.21129+05	.78560+04	.13381+05	.00000	.00000
.2500	.14095-02	.36548-02	.00000	.57654-02	.45492+04	.18585+05	.48651+04	.90760+04	.00000	.00000

MAIN SHELL PART NO 4

.0000	.36548-02	.14095-02	.00000	.57655-02	.15618+04	.13172+04	.12954+05	.19881+05	.00000	.00000
.0227	.37856-02	.14328-02	.00000	.57364-02	.28248+03	.39422+03	.12109+05	.18903+05	.00000	.00000
.0455	.39156-02	.14562-02	.00000	.56968-02	.21520+04	.21381+04	.11238+05	.17906+05	.00000	.00000
.0682	.40445-02	.14797-02	.00000	.56667-02	.40473+04	.39145+04	.10341+05	.16891+05	.00000	.00000

.0682	.40445-02	.14797-02	.00000	.56467-02	.40473+04	.39145+04	.10341+05	.16891+05	.00000	.00000
.0909	.41722-02	.15032-02	.00000	.55859-02	.59688+04	.57234+04	.94185+04	.15856+05	.00000	.00000
.1137	.42984-02	.15268-02	.00000	.55142-02	.79170+04	.75648+04	.84716+04	.14802+05	.00000	.00000
.1364	.44228-02	.15504-02	.00000	.54315-02	.98922+04	.94387+04	.75003+04	.13729+05	.00000	.00000

.1364	.44228-02	.15504-02	.00000	.54315-02	.98922+04	.94387+04	.75003+04	.13729+05	.00000	.00000
.1591	.45453-02	.15741-02	.00000	.53375-02	.11895+05	.11345+05	.65051+04	.12638+05	.00000	.00000
.1819	.46654-02	.15978-02	.00000	.52322-02	.13925+05	.13284+05	.54862+04	.11528+05	.00000	.00000
.2046	.47831-02	.16215-02	.00000	.51154-02	.15984+05	.15256+05	.44440+04	.10398+05	.00000	.00000

.2046	.47831-02	.16215-02	.00000	.51154-02	.15984+05	.15256+05	.44440+04	.10398+05	.00000	.00000
.2273	.48979-02	.16454-02	.00000	.49869-02	.18071+05	.17259+05	.33787+04	.92500+04	.00000	.00000
.2501	.50097-02	.16692-02	.00000	.48465-02	.20186+05	.19296+05	.72907+04	.80829+04	.00000	.00000
.2728	.51182-02	.16931-02	.00000	.46941-02	.22331+05	.21365+05	.11802+04	.68969+04	.00000	.00000

.2728	.51182-02	.16931-02	.00000	.46941-02	.22331+05	.21365+05	.11802+04	.68969+04	.00000	.00000
.2955	.52231-02	.17170-02	.00000	.45295-02	.24504+05	.23466+05	.47413+02	.56921+04	.00000	.00000
.3183	.53240-02	.17410-02	.00000	.43525-02	.26707+05	.25600+05	.11075+04	.44685+04	.00000	.00000
.3410	.54209-02	.17649-02	.00000	.41630-02	.28939+05	.27767+05	.22842+04	.32260+04	.00000	.00000

MAIN SHELL PART NO 5

.0000	.54209-02	.17649-02	.00000	.41630-02	.26981+05	.25849+05	.13732+04	.41248+04	.00000	.00000
.0111	.54664-02	.17766-02	.00000	.40750-02	.27998+05	.26835+05	.19197+04	.35471+04	.00000	.00000
.0221	.55110-02	.17883-02	.00000	.39844-02	.29021+05	.27828+05	.24709+04	.29654+04	.00000	.00000
.0332	.55546-02	.18000-02	.00000	.38910-02	.30051+05	.28828+05	.30267+04	.23797+04	.00000	.00000

.0332	.55546-02	.18000-02	.00000	.38910-02	.30051+05	.28828+05	.30267+04	.23797+04	.00000	.00000
.0443	.55971-02	.18117-02	.00000	.37948-02	.31088+05	.29836+05	.35872+04	.17900+04	.00000	.00000
.0553	.56386-02	.18234-02	.00000	.36960-02	.32132+05	.30851+05	.41523+04	.11963+04	.00000	.00000
.0664	.56789-02	.18351-02	.00000	.35943-02	.33182+05	.31873+05	.47219+04	.59864+03	.00000	.00000

.0664	.56789-02	.18352-02	.00000	.35943-02	.33182+05	.31873+05	.47219+04	.59864+03	.00000	.00000
.0775	.57181-02	.18469-02	.00000	.34899-02	.34239+05	.32903+05	.52962+04	.30640+01	.00000	.00000
.0885	.57562-02	.18586-02	.00000	.33826-02	.35303+05	.33940+05	.58750+04	.60879+03	.00000	.00000
.0996	.57930-02	.18703-02	.00000	.32725-02	.36374+05	.34984+05	.64584+04	.12185+04	.00000	.00000

.0996	.57930-02	.18703-02	.00000	.32725-02	.36374+05	.34984+05	.64584+04	.12185+04	.00000	.00000
.1107	.58286-02	.18821-02	.00000	.31594-02	.37451+05	.36036+05	.70463+04	.18323+04	.00000	.00000
.1217	.58629-02	.18938-02	.00000	.30438-02	.38535+05	.37095+05	.76388+04	.24501+04	.00000	.00000
.1328	.58960-02	.19056-02	.00000	.29252-02	.39626+05	.38161+05	.82358+04	.30719+04	.00000	.00000

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.1328	-.58960-02	.19056-02	.00000	.29252-02	.39626+05	-.38161+05	.82558+04	-.30719+04	.00000	.00000
.1439	-.59277-02	.19174-02	.00000	.28036-02	.40724+05	-.39234+05	.88373+04	-.36977+04	.00000	.00000
.1549	-.59580-02	.19291-02	.00000	.26791-02	.41829+05	-.40315+05	.94034+04	-.43776+04	.00000	.00000
.1660	-.59869-02	.19409-02	.00000	.25517-02	.42940+05	-.41403+05	.10054+05	-.49615+04	.00000	.00000

MAIN SHELL PART NO 6

.0000	.19409-02	.59869-02	.00000	.25517-02	.61066+05	-.50478+05	.20635+05	-.12828+05	.00000	.00000
.0033	.19325-02	.59910-02	.00000	.24949-02	.60978+05	-.50391+05	.20462+05	-.12949+05	.00000	.00000
.0067	.19243-02	.59950-02	.00000	.24383-02	.60892+05	-.50304+05	.20292+05	-.13067+05	.00000	.00000
.0100	.19162-02	.59990-02	.00000	.23817-02	.60807+05	-.50219+05	.20125+05	-.13183+05	.00000	.00000

.0100	.19162-02	.59990-02	.00000	.23811-02	.60813+05	-.50225+05	.20127+05	-.13184+05	.00000	.00000
.0133	.19084-02	.60030-02	.00000	.23247-02	.60730+05	-.50141+05	.19965+05	-.13297+05	.00000	.00000
.0167	.19007-02	.60070-02	.00000	.22683-02	.60648+05	-.50059+05	.19806+05	-.13406+05	.00000	.00000
.0200	.18933-02	.60111-02	.00000	.22120-02	.60567+05	-.49978+05	.19651+05	-.13513+05	.00000	.00000

.0200	.18933-02	.60111-02	.00000	.22120-02	.60567+05	-.49978+05	.19651+05	-.13513+05	.00000	.00000
.0233	.18860-02	.60151-02	.00000	.21558-02	.60487+05	-.49899+05	.19499+05	-.13617+05	.00000	.00000
.0267	.18789-02	.60192-02	.00000	.20996-02	.60410+05	-.49821+05	.19352+05	-.13718+05	.00000	.00000
.0300	.18720-02	.60232-02	.00000	.20436-02	.60333+05	-.49745+05	.19208+05	-.13816+05	.00000	.00000

.0300	.18720-02	.60232-02	.00000	.20435-02	.60334+05	-.49745+05	.19208+05	-.13816+05	.00000	.00000
.0333	.18653-02	.60273-02	.00000	.19876-02	.60259+05	-.49671+05	.19068+05	-.13911+05	.00000	.00000
.0367	.18587-02	.60313-02	.00000	.19316-02	.60186+05	-.49598+05	.18931+05	-.14004+05	.00000	.00000
.0400	.18524-02	.60354-02	.00000	.18758-02	.60114+05	-.49526+05	.18798+05	-.14094+05	.00000	.00000

.0400	.18524-02	.60354-02	.00000	.18758-02	.60114+05	-.49526+05	.18798+05	-.14094+05	.00000	.00000
.0433	.18462-02	.60394-02	.00000	.18200-02	.60045+05	-.49456+05	.18669+05	-.14181+05	.00000	.00000
.0467	.18403-02	.60435-02	.00000	.17643-02	.59976+05	-.49388+05	.18544+05	-.14265+05	.00000	.00000
.0500	.18345-02	.60476-02	.00000	.17087-02	.59916+05	-.49321+05	.18423+05	-.14346+05	.00000	.00000

MAIN SHELL PART NO 7

.0000	.60476-02	-.18345-02	.00000	.17087-02	.34428+05	-.35480+05	.14523+05	-.13938+05	.00000	.00000
.0184	.60174-02	-.18152-02	.00000	.15603-02	.32778+05	-.33845+05	.13751+05	-.13148+05	.00000	.00000
.0369	.59900-02	-.17960-02	.00000	.14188-02	.31137+05	-.32225+05	.12993+05	-.12371+05	.00000	.00000
.0553	.59650-02	-.17768-02	.00000	.12842-02	.29511+05	-.30618+05	.12248+05	-.11608+05	.00000	.00000

.0553	.59650-02	-.17768-02	.00000	.12842-02	.29511+05	-.30618+05	.12248+05	-.11608+05	.00000	.00000
.0738	.59425-02	-.17575-02	.00000	.11565-02	.27897+05	-.29024+05	.11517+05	-.10857+05	.00000	.00000
.0922	.59223-02	-.17383-02	.00000	.10356-02	.26296+05	-.27444+05	.10801+05	-.10120+05	.00000	.00000
.1107	.59043-02	-.17191-02	.00000	.92144-03	.24708+05	-.25877+05	.10099+05	-.93962+04	.00000	.00000

.1107	.59043-02	-.17191-02	.00000	.92144-03	.24708+05	-.25877+05	.10099+05	-.93962+04	.00000	.00000
.1291	.58883-02	-.16999-02	.00000	.81405-03	.23132+05	-.24323+05	.94107+04	-.86862+04	.00000	.00000
.1476	.58742-02	-.16808-02	.00000	.71334-03	.21567+05	-.22781+05	.87376+04	-.79902+04	.00000	.00000
.1660	.58620-02	-.16616-02	.00000	.61929-03	.20014+05	-.21252+05	.80794+04	-.73083+04	.00000	.00000

MAIN SHELL PART NO 8

.0000	.58620-02	-.16616-02	.00000	.61929-03	.13813+05	-.14844+05	.65197+04	-.56867+04	.00000	.00000
.0228	.58486-02	-.16378-02	.00000	.55856-03	.12477+05	-.13537+05	.59849+04	-.51236+04	.00000	.00000
.0456	.58365-02	-.16141-02	.00000	.50370-03	.11153+05	-.12242+05	.54673+04	-.45764+04	.00000	.00000
.0683	.58256-02	-.15904-02	.00000	.45469-03	.98385+04	-.10959+05	.49673+04	-.40453+04	.00000	.00000

.0683	.58256-02	-.15904-02	.00000	.45469-03	.98385+04	-.10959+05	.49673+04	-.40453+04	.00000	.00000
.0911	.58157-02	-.15667-02	.00000	.41149-03	.85346+04	-.96875+04	.44853+04	-.35309+04	.00000	.00000
.1139	.58068-02	-.15430-02	.00000	.37408-03	.72404+04	-.84274+04	.40219+04	-.30334+04	.00000	.00000
.1367	.57986-02	-.15194-02	.00000	.34243-03	.59554+04	-.71782+04	.35776+04	-.25533+04	.00000	.00000

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.1367	.57986-02	.15194-02	.00000	.34243-03	.59554+04	.71781+04	.35776+04	.25533+04	.00000	.00000
.1594	.57911-02	.14957-02	.00000	.31652-03	.46789+04	.59397+04	.31529+04	.70911+04	.00000	.00000
.1822	.57842-02	.14721-02	.00000	.29634-03	.34104+04	.47101+04	.27486+04	.16474+04	.00000	.00000
.2050	.57776-02	.14485-02	.00000	.28186-03	.21491+04	.34904+04	.23653+04	.12225+04	.00000	.00000
MAYN SHELL PART NO 9										
.0000	.14485-02	.57776-02	.00000	.28186-03	.75756+05	.47028+05	.23499+05	.13336+05	.00000	.00000
.0740	.15823-02	.58475-02	.00000	.36128-02	.53767+05	.25039+05	.19903+05	.37386+04	.00000	.00000
.1479	.19496-02	.59273-02	.00000	.61634-02	.41623+05	.11537+05	.23211+05	.72627+04	.00000	.00000
.2219	.24803-02	.60144-02	.00000	.80963-02	.34489+05	.10093+04	.28800+05	.18756+05	.00000	.00000
.2219	.24800-02	.60144-02	.00000	.80928-02	.34481+05	.10181+04	.28790+05	.18752+05	.00000	.00000
.2958	.31278-02	.61184-02	.00000	.92391-02	.25938+05	.17449+05	.36497+05	.33980+05	.00000	.00000
.3698	.38007-02	.62746-02	.00000	.84308-02	.98374+04	.45614+05	.42501+05	.53235+05	.00000	.00000
.4437	.43168-02	.64928-02	.00000	.56019-02	.12511+05	.44061+05	.50576+05	.60041+05	.00000	.00000
.4437	.43143-02	.64931-02	.00000	.55940-02	.12562+05	.44009+05	.50535+05	.59970+05	.00000	.00000
.5177	.46492-02	.66969-02	.00000	.36262-02	.18841+05	.37730+05	.55645+05	.61312+05	.00000	.00000
.5917	.48733-02	.68874-02	.00000	.25681-02	.23951+05	.32620+05	.57943+05	.60544+05	.00000	.00000
.6656	.50452-02	.70723-02	.00000	.21624-02	.27152+05	.29419+05	.58512+05	.59193+05	.00000	.00000
.6656	.50458-02	.70722-02	.00000	.21634-02	.27124+05	.29447+05	.58518+05	.59215+05	.00000	.00000
.7396	.52027-02	.72590-02	.00000	.21198-02	.28661+05	.27911+05	.58262+05	.58037+05	.00000	.00000
.8135	.53629-02	.74529-02	.00000	.22259-02	.29127+05	.27444+05	.57760+05	.57255+05	.00000	.00000
.8875	.55325-02	.76568-02	.00000	.23582-02	.29058+05	.27514+05	.57305+05	.56842+05	.00000	.00000
.8875	.55336-02	.76566-02	.00000	.23673-02	.29075+05	.27497+05	.57334+05	.56861+05	.00000	.00000
.9615	.57129-02	.78717-02	.00000	.24733-02	.28818+05	.27754+05	.57355+05	.56715+05	.00000	.00000
1.0354	.58984-02	.80983-02	.00000	.25373-02	.28564+05	.28005+05	.56874+05	.56705+05	.00000	.00000
1.1094	.60873-02	.83360-02	.00000	.25472-02	.28396+05	.28176+05	.56810+05	.56744+05	.00000	.00000
1.1094	.60882-02	.83359-02	.00000	.25728-02	.28398+05	.28178+05	.56829+05	.56765+05	.00000	.00000
1.1833	.62789-02	.85848-02	.00000	.25813-02	.28294+05	.28277+05	.56825+05	.56820+05	.00000	.00000
1.2573	.64498-02	.88838-02	.00000	.25789-02	.28259+05	.28316+05	.56841+05	.56860+05	.00000	.00000
1.3312	.66603-02	.91128-02	.00000	.25733-02	.28251+05	.28321+05	.56860+05	.56881+05	.00000	.00000
1.3312	.66601-02	.91129-02	.00000	.25698-02	.28233+05	.28339+05	.56851+05	.56882+05	.00000	.00000
1.4052	.68499-02	.93927-02	.00000	.25619-02	.28245+05	.28326+05	.56857+05	.56881+05	.00000	.00000
1.4792	.70392-02	.96826-02	.00000	.25577-02	.28277+05	.28294+05	.56859+05	.56864+05	.00000	.00000
1.5531	.72284-02	.99827-02	.00000	.25406-02	.28336+05	.28236+05	.56866+05	.56836+05	.00000	.00000
1.5531	.72284-02	.99828-02	.00000	.25558-02	.28299+05	.28272+05	.56855+05	.56847+05	.00000	.00000
1.6271	.74176-02	.10293-01	.00000	.25638-02	.28377+05	.28195+05	.56868+05	.56813+05	.00000	.00000
1.7010	.76080-02	.10413-01	.00000	.25879-02	.28497+05	.28075+05	.56917+05	.56791+05	.00000	.00000
1.7750	.78019-02	.10943-01	.00000	.26344-02	.28645+05	.27927+05	.57029+05	.56813+05	.00000	.00000
1.7750	.78009-02	.10943-01	.00000	.26293-02	.28609+05	.27962+05	.57016+05	.56822+05	.00000	.00000
1.8490	.79976-02	.11783-01	.00000	.26921-02	.28714+05	.27857+05	.57192+05	.56935+05	.00000	.00000
1.9229	.81993-02	.11633-01	.00000	.27624-02	.28680+05	.27892+05	.57169+05	.56933+05	.00000	.00000
1.9969	.84057-02	.11995-01	.00000	.28146-02	.28508+05	.28064+05	.57040+05	.56907+05	.00000	.00000
1.9969	.84056-02	.11995-01	.00000	.28088-02	.28471+05	.28101+05	.57026+05	.56915+05	.00000	.00000
2.0708	.86139-02	.12769-01	.00000	.28189-02	.28216+05	.28356+05	.56889+05	.56931+05	.00000	.00000
2.1448	.88215-02	.12756-01	.00000	.27871-02	.28021+05	.28479+05	.56729+05	.56866+05	.00000	.00000
2.2187	.90265-02	.13154-01	.00000	.27616-02	.28034+05	.28195+05	.56556+05	.56604+05	.00000	.00000
2.2187	.90268-02	.13154-01	.00000	.27633-02	.28030+05	.28201+05	.56562+05	.56613+05	.00000	.00000
2.2927	.92309-02	.13563-01	.00000	.27591-02	.28011+05	.27954+05	.56337+05	.56320+05	.00000	.00000

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2.3667	.94353-02	.13983-01	.00000	-.27705-02	.27955+05	.27744+05	.56084+05	.56022+05	.00000	.00000
2.4406	.96410-02	.14414-01	.00000	-.27917-02	.27869+05	.27572+05	.55826+05	.55737+05	.00000	.00000
2.4406	.96408-02	.14414-01	.00000	-.27854-02	.27828+05	.27613+05	.55810+05	.55746+05	.00000	.00000
2.5146	.98475-02	.14857-01	.00000	-.28041-02	.27708+05	.27475+05	.55540+05	.55471+05	.00000	.00000
2.5885	.10056-01	.15312-01	.00000	-.28234-02	.27581+05	.27347+05	.55275+05	.55205+05	.00000	.00000
2.6625	.10265-01	.15778-01	.00000	-.28426-02	.27453+05	.27221+05	.55017+05	.54947+05	.00000	.00000
2.6625	.10265-01	.15778-01	.00000	-.28425-02	.27442+05	.27732+05	.55017+05	.54954+05	.00000	.00000
2.7365	.10476-01	.16257-01	.00000	-.28592-02	.27308+05	.27114+05	.54761+05	.54703+05	.00000	.00000
2.8104	.10688-01	.16747-01	.00000	-.28745-02	.27175+05	.26999+05	.54507+05	.54455+05	.00000	.00000
2.8844	.10901-01	.17249-01	.00000	-.28882-02	.27043+05	.26884+05	.54253+05	.54206+05	.00000	.00000
2.8844	.10901-01	.17249-01	.00000	-.28845-02	.27014+05	.26913+05	.54245+05	.54214+05	.00000	.00000
2.9583	.11115-01	.17764-01	.00000	-.28913-02	.26874+05	.26808+05	.53976+05	.53957+05	.00000	.00000
3.0323	.11329-01	.18290-01	.00000	-.28963-02	.26753+05	.26688+05	.53700+05	.53680+05	.00000	.00000
3.1062	.11543-01	.18829-01	.00000	-.29043-02	.26675+05	.26525+05	.53424+05	.53379+05	.00000	.00000
3.1062	.11544-01	.18829-01	.00000	-.29064-02	.26674+05	.26526+05	.53430+05	.53386+05	.00000	.00000
3.1802	.11759-01	.19380-01	.00000	-.29265-02	.26669+05	.26294+05	.53176+05	.53064+05	.00000	.00000
3.2542	.11977-01	.19942-01	.00000	-.29737-02	.26773+05	.25954+05	.52981+05	.52735+05	.00000	.00000
3.3281	.12200-01	.20515-01	.00000	-.30673-02	.27000+05	.25493+05	.52902+05	.52449+05	.00000	.00000
3.3281	.12200-01	.20515-01	.00000	-.30603-02	.26958+05	.25535+05	.52884+05	.52457+05	.00000	.00000
3.4021	.12431-01	.21100-01	.00000	-.32093-02	.27247+05	.25014+05	.52966+05	.52296+05	.00000	.00000
3.4760	.12676-01	.21695-01	.00000	-.34210-02	.27458+05	.24574+05	.53263+05	.52398+05	.00000	.00000
3.5500	.12938-01	.22302-01	.00000	-.36577-02	.27255+05	.24550+05	.53743+05	.52932+05	.00000	.00000
3.5500	.12938-01	.22302-01	.00000	-.36566-02	.27240+05	.24564+05	.53741+05	.52938+05	.00000	.00000
3.6240	.13215-01	.22923-01	.00000	-.38056-02	.26061+05	.25518+05	.54196+05	.54033+05	.00000	.00000
3.6979	.13494-01	.23562-01	.00000	-.36531-02	.23191+05	.28164+05	.54083+05	.55575+05	.00000	.00000
3.7719	.13740-01	.24228-01	.00000	-.28670-02	.17987+05	.33147+05	.52616+05	.57164+05	.00000	.00000
3.7719	.13741-01	.24228-01	.00000	-.28721-02	.18002+05	.33131+05	.52629+05	.57168+05	.00000	.00000
3.8458	.13893-01	.24930-01	.00000	-.10530-02	.10369+05	.40545+05	.48621+05	.57673+05	.00000	.00000
3.9198	.13876-01	.25654-01	.00000	-.11894-02	.13839+05	.29266+05	.44710+05	.49338+05	.00000	.00000
3.9937	.13767-01	.26340-01	.00000	-.16144-02	.16907+05	.17552+05	.38943+05	.39136+05	.00000	.00000
3.9937	.13787-01	.26335-01	.00000	-.14708-02	.16700+05	.17759+05	.39260+05	.39577+05	.00000	.00000
4.0677	.13679-01	.27023-01	.00000	-.14175-02	.15453+05	.13250+05	.32281+05	.31620+05	.00000	.00000
4.1417	.13578-01	.27722-01	.00000	-.13324-02	.12472+05	.12942+05	.24949+05	.25090+05	.00000	.00000
4.2156	.13473-01	.28441-01	.00000	-.15770-02	.73143+04	.18099+05	.16938+05	.20174+05	.00000	.00000
4.2156	.13472-01	.28441-01	.00000	-.15846-02	.73682+04	.18045+05	.16934+05	.20137+05	.00000	.00000
4.2896	.13334-01	.29182-01	.00000	-.21617-02	.49332+04	.20481+05	.91849+04	.13849+05	.00000	.00000
4.3635	.13152-01	.29943-01	.00000	-.27407-02	.78586+04	.17555+05	.72554+04	.51644+04	.00000	.00000
4.4375	.12943-01	.30720-01	.00000	-.27445-02	.19099+05	.63142+04	.25950+04	.64306+04	.00000	.00000
MAIN SHELL PART NO 10										
1.5768	.12943-01	.30720-01	.00000	-.27452-02	.19092+05	.63216+04	.25979+04	.64290+04	.00000	.00000
1.6134	.14206-01	.30283-01	.00000	-.26271-02	.21932+05	.36834+04	.23244+04	.79325+04	.00000	.00000
1.6559	.15450-01	.29793-01	.00000	-.24691-02	.24500+05	.13140+04	.21200+04	.93265+04	.00000	.00000
1.6559	.15450-01	.29793-01	.00000	-.24691-02	.24500+05	.13139+04	.21199+04	.93264+04	.00000	.00000
1.6985	.16675-01	.29251-01	.00000	-.22740-02	.26808+05	.79930+03	.19764+04	.10605+05	.00000	.00000
1.7410	.17878-01	.28660-01	.00000	-.20441-02	.28870+05	.26666+04	.18860+04	.11762+05	.00000	.00000
1.7410	.17878-01	.28660-01	.00000	-.20441-02	.28870+05	.26666+04	.18860+04	.11762+05	.00000	.00000
1.7836	.19058-01	.28020-01	.00000	-.17812-02	.30696+05	.42961+04	.18414+04	.12791+05	.00000	.00000

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1.8262	.20213-01	.27333-01	.00000	.14868-02	.32295+05	-.56937+04	-.18355+04	-.13684+05	.00000	.00000
1.8262	.20213-01	.27333-01	.00000	.14867-02	.32295+05	-.56937+04	-.18354+04	-.13684+05	.00000	.00000
1.8687	.21342-01	.26602-01	.00000	.11617-02	.33673+05	-.68636+04	-.18608+04	-.14433+05	.00000	.00000
1.9113	.22443-01	.25828-01	.00000	.80692-03	.34836+05	-.78083+04	-.19098+04	-.15029+05	.00000	.00000
1.9113	.22443-01	.25828-01	.00000	.80689-03	.34836+05	-.78083+04	-.19098+04	-.15029+05	.00000	.00000
1.9538	.23515-01	.25012-01	.00000	.42293-03	.35789+05	-.85285+04	-.19742+04	-.15462+05	.00000	.00000
1.9964	.24559-01	.24159-01	.00000	.10263-04	.36534+05	-.90235+04	-.20449+04	-.15717+05	.00000	.00000
1.9964	.24559-01	.24159-01	.00000	.10234-04	.36534+05	-.90234+04	-.20449+04	-.15717+05	.00000	.00000
2.0390	.25571-01	.23268-01	.00000	-.43074-03	.37072+05	-.92911+04	-.21118+04	-.15782+05	.00000	.00000
2.0815	.26554-01	.22344-01	.00000	-.89959-03	.37406+05	-.93279+04	-.21630+04	-.15640+05	.00000	.00000
2.0815	.26554-01	.22344-01	.00000	-.89964-03	.37406+05	-.93278+04	-.21631+04	-.15640+05	.00000	.00000
2.1241	.27506-01	.21389-01	.00000	-.13958-02	.37535+05	-.91289+04	-.21853+04	-.15271+05	.00000	.00000
2.1666	.28427-01	.20405-01	.00000	-.19184-02	.37456+05	-.86881+04	-.21630+04	-.14654+05	.00000	.00000
2.1666	.28427-01	.20405-01	.00000	-.19185-02	.37456+05	-.86880+04	-.21631+04	-.14654+05	.00000	.00000
2.2092	.29320-01	.19395-01	.00000	-.24664-02	.37168+05	-.79979+04	-.20781+04	-.13764+05	.00000	.00000
2.2518	.30184-01	.18362-01	.00000	-.30375-02	.36665+05	-.70494+04	-.19097+04	-.12573+05	.00000	.00000
2.2518	.30184-01	.18362-01	.00000	-.30376-02	.36665+05	-.70491+04	-.19098+04	-.12573+05	.00000	.00000
2.2943	.31022-01	.17310-01	.00000	-.36297-02	.35939+05	-.58309+04	-.16338+04	-.11047+05	.00000	.00000
2.3369	.31836-01	.16242-01	.00000	-.42369-02	.34978+05	-.43285+04	-.12230+04	-.91483+04	.00000	.00000
2.3369	.31836-01	.16242-01	.00000	-.42371-02	.34978+05	-.43280+04	-.12233+04	-.91482+04	.00000	.00000
2.3794	.32629-01	.15161-01	.00000	-.48546-02	.33761+05	-.25226+04	-.64718+03	-.68342+04	.00000	.00000
2.4220	.33405-01	.14072-01	.00000	-.54725-02	.32257+05	-.38674+03	.12718+03	-.40556+04	.00000	.00000
2.4220	.33405-01	.14072-01	.00000	-.54728-02	.32257+05	-.38676+03	.12651+03	-.40555+04	.00000	.00000
2.4646	.34168-01	.12979-01	.00000	-.60775-02	.30414+05	.21198+04	.11334+04	-.75659+03	.00000	.00000
2.5071	.34923-01	.11886-01	.00000	-.66486-02	.28149+05	.50565+04	.24050+04	.31246+04	.00000	.00000
2.5071	.34923-01	.11886-01	.00000	-.66492-02	.28149+05	.50581+04	.24034+04	.31241+04	.00000	.00000
2.5497	.35674-01	.10797-01	.00000	-.71558-02	.25330+05	.85197+04	.39659+04	.76539+04	.00000	.00000
2.5922	.36426-01	.97173-02	.00000	-.75508-02	.21745+05	.12658+05	.58294+04	.12899+05	.00000	.00000
2.5922	.36426-01	.97174-02	.00000	-.75519-02	.21746+05	.12661+05	.58253+04	.12896+05	.00000	.00000
2.6348	.37180-01	.86526-02	.00000	-.77614-02	.17067+05	.17710+05	.79736+04	.18908+05	.00000	.00000
2.6774	.37930-01	.76081-02	.00000	-.76682-02	.10773+05	.24046+05	.10339+05	.25698+05	.00000	.00000
2.6774	.37930-01	.76084-02	.00000	-.76704-02	.10778+05	.24050+05	.10328+05	.25691+05	.00000	.00000
2.7199	.38660-01	.65906-02	.00000	-.70857-02	.20917+04	.32240+05	.12769+05	.33161+05	.00000	.00000
2.7625	.39332-01	.56072-02	.00000	-.57027-02	-.10177+05	.43178+05	.15020+05	.40972+05	.00000	.00000
2.7625	.39331-01	.56079-02	.00000	-.57074-02	-.10158+05	.43186+05	.14990+05	.40948+05	.00000	.00000
2.8050	.39866-01	.46696-02	.00000	-.30288-02	-.27674+05	.58159+05	.16644+05	.48216+05	.00000	.00000
2.8476	.40110-01	.37922-02	.00000	-.17511-02	-.52824+05	.79145+05	.17109+05	.52929+05	.00000	.00000

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MAIN SHELL PART NO 11										
.0000	.20483-01	.34689-01	.00000	.17417-02	-.57892+04	.15200+05	.30049+05	.33582+05	.00000	.00000
.0529	.20384-01	.35210-01	.00000	.19695-02	.43820+03	.86769+04	.29575+05	.29170+05	.00000	.00000
.0529	.20384-01	.35210-01	.00000	.19695-02	.43820+03	.86769+04	.29575+05	.29170+05	.00000	.00000
.1058	.20277-01	.35735-01	.00000	.20258-02	.58917+04	.31209+04	.28319+05	.24799+05	.00000	.00000
.1058	.20277-01	.35735-01	.00000	.20258-02	.58918+04	.31209+04	.28319+05	.24798+05	.00000	.00000
.1588	.20172-01	.36263-01	.00000	.19004-02	.10308+05	-.11220+04	.26519+05	.20835+05	.00000	.00000



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.1588	.20172-01	.36263-01	.00000	.19003-02	.1030A+05	-.11221+04	.26519+05	.20834+05	.00000	.00000
.2117	.20079-01	.36793-01	.00000	.1595A-02	.13212+05	-.34656+04	.24409+05	.17747+05	.00000	.00000
.2117	.20079-01	.36793-01	.00000	.1595A-02	.13212+05	-.34657+04	.24409+05	.17747+05	.00000	.00000
.2646	.20006-01	.37325-01	.00000	.11601-02	.13504+05	-.26258+04	.22052+05	.16189+05	.00000	.00000
.2646	.20006-01	.37325-01	.00000	.11601-02	.13504+05	-.26260+04	.22052+05	.16189+05	.00000	.00000
.3175	.19955-01	.37860-01	.00000	.81215-03	.81099+04	.48430+04	.18782+05	.17219+05	.00000	.00000

MAIN SHELL PART NO 12

.0000	.64536-02	.42308-01	.00000	.81220-03	.89927+04	.53297+04	.18755+05	.17656+05	.00000	.00000
.0739	.64030-02	.43059-01	.00000	.53916-03	.99615+04	.83610+04	.16993+05	.15313+05	.00000	.00000
.1478	.63738-02	.43811-01	.00000	.26345-03	.93304+04	.49920+04	.15617+05	.14316+05	.00000	.00000
.2217	.63617-02	.44564-01	.00000	.80753-04	.83844+04	.59380+04	.14843+05	.14109+05	.00000	.00000
.2217	.63617-02	.44564-01	.00000	.80649-04	.83845+04	.59380+04	.14843+05	.14109+05	.00000	.00000
.2956	.63596-02	.45318-01	.00000	-.10058-04	.76741+04	.66483+04	.14544+05	.14236+05	.00000	.00000
.3694	.63618-02	.46071-01	.00000	-.43022-04	.73129+04	.70096+04	.14525+05	.14434+05	.00000	.00000
.4433	.63654-02	.46824-01	.00000	-.52415-04	.72157+04	.71068+04	.14641+05	.14608+05	.00000	.00000
.4433	.63642-02	.46824-01	.00000	-.34559-04	.70978+04	.72247+04	.14559+05	.14597+05	.00000	.00000
.5172	.63665-02	.47577-01	.00000	-.28335-04	.71280+04	.71944+04	.14661+05	.14681+05	.00000	.00000
.5911	.63686-02	.48331-01	.00000	-.29672-04	.72223+04	.71002+04	.14774+05	.14737+05	.00000	.00000
.6650	.63712-02	.49084-01	.00000	-.40519-04	.72877+04	.70347+04	.14897+05	.14821+05	.00000	.00000
.6650	.63718-02	.49084-01	.00000	-.51557-04	.73661+04	.69563+04	.14948+05	.14825+05	.00000	.00000
.7389	.63764-02	.49836-01	.00000	-.71758-04	.72868+04	.70356+04	.15111+05	.15036+05	.00000	.00000
.8128	.63818-02	.50589-01	.00000	-.65417-04	.68375+04	.74850+04	.15194+05	.15388+05	.00000	.00000
.8867	.63842-02	.51342-01	.00000	.19596-04	.57986+04	.85238+04	.14979+05	.15797+05	.00000	.00000
.8867	.63847-02	.51342-01	.00000	.10607-04	.58625+04	.84600+04	.15021+05	.15400+05	.00000	.00000
.9606	.63767-02	.52094-01	.00000	.23744-03	.41577+04	.10165+05	.14183+05	.15986+05	.00000	.00000
1.0344	.63445-02	.52848-01	.00000	.67159-03	.21613+04	.12161+05	.12275+05	.15275+05	.00000	.00000
1.1083	.62730-02	.53603-01	.00000	.12784-02	.13290+04	.12993+05	.91245+04	.12624+05	.00000	.00000
1.1083	.62736-02	.53603-01	.00000	.12682-02	.14009+04	.12922+05	.91713+04	.12627+05	.00000	.00000
1.1822	.61594-02	.54361-01	.00000	.17621-02	.48516+04	.94704+04	.55697+04	.69554+04	.00000	.00000
1.2561	.60328-02	.55125-01	.00000	.14401-02	.17413+05	.30902+04	.41971+04	.19537+04	.00000	.00000
1.3300	.59976-02	.55891-01	.00000	-.97125-03	.44212+05	-.29890+05	.10810+05	-.11421+05	.00000	.00000

MAIN SHELL PART NO 13

.0000	.53882-01	.16017-01	.00000	-.98000-03	.12951+05	-.63538+04	-.37973+03	-.25001+04	.00000	.00000
.0484	.53936-01	.16512-01	.00000	-.12116-02	.61228+04	.54624+03	-.28664+04	.85402+03	.00000	.00000
.0484	.53936-01	.16512-01	.00000	-.12116-02	.61228+04	.54621+03	-.28663+04	.85413+03	.00000	.00000
.0968	.53996-01	.17007-01	.00000	-.12631-02	.22029+04	.45604+04	-.40563+04	.33201+04	.00000	.00000
.0968	.53996-01	.17007-01	.00000	-.12631-02	.22029+04	.45605+04	-.40562+04	.33201+04	.00000	.00000
.1452	.54057-01	.17502-01	.00000	-.12301-02	.17464+03	.66630+04	-.44221+04	.52337+04	.00000	.00000
.1452	.54057-01	.17502-01	.00000	-.12300-02	.17446+03	.66634+04	-.44219+04	.52332+04	.00000	.00000
.1936	.54115-01	.17996-01	.00000	-.11666-02	.60764+03	.74558+04	-.42632+04	.68621+04	.00000	.00000
.1936	.54115-01	.17996-01	.00000	-.11665-02	.60789+03	.74563+04	-.42632+04	.68615+04	.00000	.00000
.2420	.54170-01	.18490-01	.00000	-.11037-02	-.57367+03	.73071+04	-.37729+04	.84600+04	.00000	.00000
.2420	.54170-01	.18490-01	.00000	-.11036-02	-.57407+03	.73078+04	-.37727+04	.84595+04	.00000	.00000



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.2905	.63602-01	.22854-01	.00000	-.23822-02	-.76641+02	.14439+05	-.69150+04	.23208+05	.00000	.00000
HAYN SHELL PART NO 14										
.0000	.67496-01	-.34384-02	.00000	-.23821-02	-.58745+03	.13930+05	-.81471+04	.24135+05	.00000	.00000
.0233	.67551-01	-.31995-02	.00000	-.23458-02	-.22850+04	.15421+05	-.93443+04	.25538+05	.00000	.00000
.0466	.67605-01	-.29608-02	.00000	-.22965-02	-.37770+04	.16654+05	-.10490+05	.26943+05	.00000	.00000
.0466	.67605-01	-.29608-02	.00000	-.22965-02	-.37770+04	.16654+05	-.10490+05	.26943+05	.00000	.00000
.0699	.67658-01	-.27222-02	.00000	-.22370-02	-.50442+04	.17591+05	-.11600+05	.28384+05	.00000	.00000
.0932	.67710-01	-.24839-02	.00000	-.21708-02	-.60584+04	.18173+05	-.12697+05	.29913+05	.00000	.00000
.0932	.67710-01	-.24839-02	.00000	-.21708-02	-.60584+04	.18173+05	-.12697+05	.29913+05	.00000	.00000
.1165	.67759-01	-.22459-02	.00000	-.21019-02	-.67760+04	.18312+05	-.13818+05	.31612+05	.00000	.00000
.1398	.67808-01	-.20083-02	.00000	-.20361-02	-.71265+04	.17863+05	-.15023+05	.33617+05	.00000	.00000
.1398	.67808-01	-.20083-02	.00000	-.20361-02	-.71265+04	.17863+05	-.15023+05	.33617+05	.00000	.00000
.1631	.67854-01	-.17713-02	.00000	-.19809-02	-.69894+04	.16574+05	-.16420+05	.36167+05	.00000	.00000
.1864	.67900-01	-.15352-02	.00000	-.19479-02	-.61450+04	.13986+05	-.18212+05	.39701+05	.00000	.00000
.1864	.67900-01	-.15352-02	.00000	-.19479-02	-.61450+04	.13986+05	-.18212+05	.39701+05	.00000	.00000
.2097	.67945-01	-.13005-02	.00000	-.19562-02	-.41503+04	.91689+04	-.20810+05	.45123+05	.00000	.00000
.2330	.67992-01	-.10681-02	.00000	-.20410-02	-.26445+01	.18633+01	-.25175+05	.54507+05	.00000	.00000

IBRM= 00 WHICH INDICATES END OF JOB. EXIT CALLED

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KALNINS SHELL STRESS ANALYSIS..... HOT END PRESSURE SHELL MORIMOTO JUN 73

SUBCASE NO 2 FOR FOURIER HARMONIC COS 0 THETA

BOUNDARY CONDITIONS AT STARTING EDGE 1= .00000 3= .00000 5= .00000 7= .00000
BOUNDARY CONDITIONS AT FINAL EDGE 2= .00000 4= .00000 6= .00000 8= .00000

LOADS FOR PART NO 1 SUBCASE NO 2

RING LOADS AT END OF THIS PART ARE Q= -.00000 NPHI= -.00000 MPHI= -.00000 N= -.00000
WK= -.00000 UK= -.00000 UTHK= -.00000

SURFACE AND TEMP LOADS ARE P= .28100+04 PFI= -.00000 PTHETA= -.00000 TL= .14000+03 TU= .14000+03

LOADS FOR PART NO 2 SUBCASE NO 2

RING LOADS AT END OF THIS PART ARE Q= -.00000 NPHI= -.00000 MPHI= -.00000 N= -.00000
WK= -.00000 UK= -.00000 UTHK= -.00000

SURFACE AND TEMP LOADS ARE P= .28100+04 PFI= -.00000 PTHETA= -.00000 TL= .14000+03 TU= .14000+03

LOADS FOR PART NO 3 SUBCASE NO 2

RING LOADS AT END OF THIS PART ARE Q= -.00000 NPHI= -.00000 MPHI= -.00000 N= -.00000
WK= -.00000 UK= -.00000 UTHK= -.00000

SURFACE AND TEMP LOADS ARE P= .28100+04 PFI= -.00000 PTHETA= -.00000 TL= .14000+03 TU= .14000+03

LOADS FOR PART NO 4 SUBCASE NO 2

RING LOADS AT END OF THIS PART ARE Q= -.00000 NPHI= -.00000 MPHI= -.00000 N= -.00000
WK= -.00000 UK= -.00000 UTHK= -.00000

SURFACE AND TEMP LOADS ARE P= .28100+04 PFI= -.00000 PTHETA= -.00000 TL= .14000+03 TU= .14000+03

LOADS FOR PART NO 5 SUBCASE NO 2

RING LOADS AT END OF THIS PART ARE Q= -.00000 NPHI= -.00000 MPHI= -.00000 N= -.00000
WK= -.00000 UK= -.00000 UTHK= -.00000

SURFACE AND TEMP LOADS ARE P= .28100+04 PFI= -.00000 PTHETA= -.00000 TL= .14000+03 TU= .14000+03

LOADS FOR PART NO 6 SUBCASE NO 2

RING LOADS AT END OF THIS PART ARE Q= -.00000 NPHI= -.00000 MPHI= -.00000 N= -.00000
WK= -.00000 UK= -.00000 UTHK= -.00000

SURFACE AND TEMP LOADS ARE P= .28100+04 PFI= -.00000 PTHETA= -.00000 TL= .14000+03 TU= .14000+03

LOADS FOR PART NO 7 SUBCASE NO 2

RING LOADS AT END OF THIS PART ARE Q= -.00000 NPHI= -.00000 MPHI= -.00000 N= -.00000



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WK= -.00000 UK= -.00000 UTHK= -.00000

SURFACE AND TEMP LOADS ARE P= .28100+04 PFI= -.00000 PTHETA= -.00000 TL= .14000+03 TU= .14000+03

LOADS FOR PART NO 8 SUBCASE NO 2

RING LOADS AT END OF THIS PART ARE Q= -.00000 NPHI= -.00000 MPHT= -.00000 N= -.00000

WK= -.00000 UK= -.00000 UTHK= -.00000

SURFACE AND TEMP LOADS ARE P= .28100+04 PFI= -.00000 PTHETA= -.00000 TL= .14000+03 TU= .14000+03

LOADS FOR PART NO 9 SUBCASE NO 2

RING LOADS AT END OF THIS PART ARE Q= -.00000 NPHI= -.00000 MPHT= -.00000 N= -.00000

WK= -.00000 UK= -.00000 UTHK= -.00000

SURFACE AND TEMP LOADS ARE P= .28100+04 PFI= -.00000 PTHETA= -.00000 TL= .67000+03 TU= .67000+03

CODE NUMBERS OF VARIABLE LOADS OVER THIS PART, GIVEN BY FGENS BELOW, ARE 4 5

TEY LINEAR FUNCTION GENERATOR NO. 14 FROM 3 POINTS

Y COORDINATES .1400+03 .1400+03 .1200+04

X COORDINATES .0000 .1250-00 .4434+01

TEN LINEAR FUNCTION GENERATOR NO. 15 FROM 3 POINTS

Y COORDINATES .1400+03 .1400+03 .1200+04

X COORDINATES .0000 .1250-00 .4438+01

LOADS FOR PART NO 10 SUBCASE NO 2

RING LOADS AT END OF THIS PART ARE Q= -.00000 NPHI= -.00000 MPHT= -.00000 N= -.00000

WK= -.00000 UK= -.00000 UTHK= -.00000

SURFACE AND TEMP LOADS ARE P= .28100+04 PFI= -.00000 PTHETA= -.00000 TL= .12000+04 TU= .12000+04

LOADS FOR PART NO 11 SUBCASE NO 2

RING LOADS AT END OF THIS PART ARE Q= -.00000 NPHI= -.00000 MPHT= -.00000 N= -.00000

WK= -.00000 UK= -.00000 UTHK= -.00000

SURFACE AND TEMP LOADS ARE P= .28100+04 PFI= -.00000 PTHETA= -.00000 TL= .12000+04 TU= .12000+04

LOADS FOR PART NO 12 SUBCASE NO 2

RING LOADS AT END OF THIS PART ARE Q= -.00000 NPHI= -.00000 MPHT= -.00000 N= -.00000

WK= -.00000 UK= -.00000 UTHK= -.00000

SURFACE AND TEMP LOADS ARE P= .28100+04 PFI= -.00000 PTHETA= -.00000 TL= .12000+04 TU= .12000+04

LOADS FOR PART NO 13 SUBCASE NO 2

PAGE 7-41

RING LOADS AT END OF THIS PART ARE O= -.00000 MPHI= -.00000 MPHT= -.00000 N= -.00000
WK= -.00000 UK= -.00000 UTHK= -.00000

SURFACE AND TEMP LOADS ARE P= .28100+04 PFI= -.00000 PTHETA= -.00000 TL= .12000+04 TU= .12000+04

LOADS FOR PART NO 14 SUBCASE NO 2

RING LOADS AT END OF THIS PART ARE O= -.00000 MPHI= -.00000 MPHT= -.00000 N= -.00000
WK= -.00000 UK= -.00000 UTHK= -.00000

SURFACE AND TEMP LOADS ARE P= .28100+04 PFI= -.00000 PTHETA= -.00000 TL= .12000+04 TU= .12000+04



AIR RESEARCH MANUFACTURING COMPANY
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KALVINS SHELL STRESS ANALYSIS..... HOT END PRESSURE SHELL MORIMOTO JUN 73

DEFLECTIONS AND STRESS RESULTANTS FOR WAVE NUMBER NX= 0 2810 PSI PLUS TEMPERATURE LOADING

X	W	Q	UPHI	NPHI	BPHI	MPHI	UTHETA	N	NTHETA	MTHETA
MAIN SHELL PART NO 1										
.0000	.00000	.77990+03	.00000	.16643+04	.00000	-.80160+02	.00000	.00000	-.15300+04	-.43326+02
.0250	.40093-04	.67866+03	.82967-04	.16643+04	-.31340-02	-.61934+02	.00000	.00000	-.14075+04	-.34883+02
.0500	.15302-03	.58114+03	.15953-03	.16643+04	-.58263-02	-.46196+02	.00000	.00000	-.11794+04	-.26617+02
.0500	.15302-03	.58114+03	.15953-03	.16643+04	-.58263-02	-.46196+02	.00000	.00000	-.11794+04	-.26617+02
.0750	.32772-03	.48928+03	.23014-03	.16643+04	-.80763-02	-.32829+02	.00000	.00000	-.87200+03	-.18968+02
.1000	.55317-03	.40448+03	.29534-03	.16643+04	-.98862-02	-.21673+02	.00000	.00000	-.50970+03	-.12253+02
.1000	.55317-03	.40448+03	.29534-03	.16643+04	-.98862-02	-.21673+02	.00000	.00000	-.50970+03	-.12253+02
.1250	.81841-03	.32765+03	.35576-03	.16643+04	-.11260-01	-.12538+02	.00000	.00000	-.11461+03	-.66774+01
.1500	.11126-02	.25926+03	.41207-03	.16643+04	-.12201-01	-.52193+01	.00000	.00000	.29329+03	-.23485+01
.1500	.11126-02	.25926+03	.41207-03	.16643+04	-.12201-01	-.52193+01	.00000	.00000	.29329+03	-.23485+01
.1750	.14249-02	.19941+03	.46502-03	.16643+04	-.12714-01	.49724-00	.00000	.00000	.69630+03	.71068-00
.2000	.17447-02	.14780+03	.51541-03	.16643+04	-.12798-01	.48207+01	.00000	.00000	.10787+04	.25472+01
.2000	.17447-02	.14781+03	.51541-03	.16643+04	-.12798-01	.48213+01	.00000	.00000	.10788+04	.25474+01
.2250	.20612-02	.10388+03	.56412-03	.16643+04	-.12451-01	.79522+01	.00000	.00000	.14270+04	.32670+01
.2500	.23636-02	.66792+02	.61209-03	.16643+04	-.11663-01	.10072+02	.00000	.00000	.17293+04	.30217+01
MAIN SHELL PART NO 2										
.0000	.23636-02	.66794+02	.61209-03	.16643+04	-.11663-01	.10073+02	.00000	.00000	.17293+04	.30219+01
.2241	.38531-02	-.42492+02	.98976-03	.16643+04	-.22677-02	.69852+01	.00000	.00000	.34036+04	.20956+01
.4482	.39331-02	-.13660+02	.13306-02	.16643+04	.56857-03	.46504-00	.00000	.00000	.34935+04	.13951-00
.4482	.39334-02	-.13421+02	.13305-02	.16643+04	.54791-03	.45649-00	.00000	.00000	.34972+04	.13695-00
.6723	.38275-02	.11132+01	.16751-02	.16643+04	.29573-03	-.48270-00	.00000	.00000	.33748+04	-.14481-00
.8964	.37978-02	.11432+01	.20236-02	.16643+04	.28222-04	-.11765+00	.00000	.00000	.33413+04	-.35296-01
.8964	.38014-02	.14093+01	.20235-02	.16643+04	.57514-05	-.12597-00	.00000	.00000	.33454+04	-.37791-01
1.1205	.38045-02	.40484+00	.23723-02	.16643+04	-.58412-05	.62528-01	.00000	.00000	.33489+04	.18758-01
1.3446	.37977-02	-.65117-00	.27211-02	.16643+04	.66790-04	.61488-01	.00000	.00000	.33413+04	.18446-01
1.3446	.38022-02	-.32041-00	.27210-02	.16643+04	.38703-04	.50902-01	.00000	.00000	.33464+04	.15271-01
1.5687	.37937-02	-.24738+01	.30701-02	.16643+04	-.31602-05	-.22517-00	.00000	.00000	.33368+04	-.67551-01
1.7928	.38404-02	-.25226+01	.34186-02	.16643+04	-.52890-03	-.95881-00	.00000	.00000	.33893+04	-.28764-00
1.7928	.38441-02	-.22526+01	.34185-02	.16643+04	-.55168-03	-.96720-00	.00000	.00000	.33934+04	-.29016-00
2.0169	.40553-02	.25247+02	.37596-02	.16643+04	-.11003-02	.75685-00	.00000	.00000	.36308+04	.22706-00
2.2410	.39215-02	.83445+02	.40926-02	.16643+04	.41867-02	.13297+02	.00000	.00000	.34804+04	.39890+01
MAIN SHELL PART NO 3										
.0000	.39260-02	.83776+02	.40925-02	.16643+04	.41586-02	.13286+02	.00000	.00000	.34855+04	.39858+01
.0250	.38058-02	.86496+02	.41298-02	.16643+04	.54390-02	.15415+02	.00000	.00000	.34708+04	.74474+01
.0500	.36549-02	.88398+02	.41658-02	.16643+04	.66213-02	.17604+02	.00000	.00000	.34072+04	.10806+02
.0500	.36549-02	.88398+02	.41658-02	.16643+04	.66213-02	.17604+02	.00000	.00000	.34072+04	.10806+02
.0750	.34754-02	.88442+02	.42009-02	.16643+04	.77197-02	.19819+02	.00000	.00000	.32931+04	.13906+02
.1000	.32695-02	.85556+02	.42355-02	.16643+04	.87428-02	.22002+02	.00000	.00000	.31273+04	.16587+02
.1000	.32695-02	.85556+02	.42355-02	.16643+04	.87429-02	.22002+02	.00000	.00000	.31273+04	.16587+02



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.1250	.30389-02	.78648+02	.42699-02	.16643+04	.96938-02	.24064+02	.00000	.00000	.29082+04	.18662+02
.1500	.27854-02	.66576+02	.43045-02	.16643+04	.10570-01	.25891+02	.00000	.00000	.26351+04	.19942+02

.1500	.27854-02	.66584+02	.43045-02	.16643+04	.10571-01	.25892+02	.00000	.00000	.26351+04	.19942+02
.1750	.25110-02	.48217+02	.43397-02	.16643+04	.11366-01	.27341+02	.00000	.00000	.23075+04	.20227+02
.2000	.22179-02	.22414+02	.43758-02	.16643+04	.12071-01	.28240+02	.00000	.00000	.19256+04	.19312+02

.2000	.22179-02	.22417+02	.43758-02	.16643+04	.12071-01	.28240+02	.00000	.00000	.19256+04	.19312+02
.2250	.19083-02	.11949+02	.44133-02	.16643+04	.12671-01	.28390+02	.00000	.00000	.14905+04	.16992+02
.2500	.15853-02	.55972+02	.44528-02	.16643+04	.13149-01	.27562+02	.00000	.00000	.10044+04	.13068+02

MAIN SHELL PART NO 4

.0000	.44528-02	.16643+04	.15853-02	.55970+02	.13149-01	.27562+02	.00000	.00000	.17354+04	.30773+03
.0227	.47510-02	.16964+04	.16076-02	.22786+02	.13083-01	.51998+01	.00000	.00000	.17022+04	.29083+03
.0455	.50475-02	.17266+04	.16300-02	.85873+01	.12994-01	.38499+02	.00000	.00000	.16708+04	.27352+03
.0682	.53416-02	.17607+04	.16526-02	.38279+02	.12881-01	.72339+02	.00000	.00000	.16411+04	.25580+03

.0682	.53416-02	.17607+04	.16526-02	.38280+02	.12881-01	.72339+02	.00000	.00000	.16411+04	.25580+03
.0909	.56329-02	.17929+04	.16753-02	.66409+02	.12744-01	.10672+03	.00000	.00000	.16130+04	.23767+03
.1137	.59209-02	.18250+04	.16981-02	.93082+02	.12583-01	.14166+03	.00000	.00000	.15863+04	.21915+03
.1364	.62049-02	.18571+04	.17210-02	.11840+03	.12397-01	.17715+03	.00000	.00000	.15610+04	.20023+03

.1364	.62049-02	.18571+04	.17210-02	.11840+03	.12397-01	.17715+03	.00000	.00000	.15610+04	.20023+03
.1591	.64843-02	.18892+04	.17441-02	.14245+03	.12186-01	.21319+03	.00000	.00000	.15370+04	.18091+03
.1819	.67587-02	.19214+04	.17672-02	.16532+03	.11949-01	.24979+03	.00000	.00000	.15141+04	.16121+03
.2046	.70274-02	.19535+04	.17905-02	.18708+03	.11687-01	.28696+03	.00000	.00000	.14923+04	.14111+03

.2046	.70274-02	.19535+04	.17905-02	.18708+03	.11687-01	.28696+03	.00000	.00000	.14923+04	.14111+03
.2273	.72899-02	.19856+04	.18138-02	.20780+03	.11398-01	.32469+03	.00000	.00000	.14716+04	.12064+03
.2501	.75455-02	.20177+04	.18372-02	.22756+03	.11083-01	.36298+03	.00000	.00000	.14519+04	.99777+02
.2728	.77936-02	.20498+04	.18607-02	.24640+03	.10741-01	.40184+03	.00000	.00000	.14330+04	.78537+02

.2728	.77936-02	.20498+04	.18607-02	.24640+03	.10741-01	.40184+03	.00000	.00000	.14330+04	.78537+02
.2955	.80336-02	.20818+04	.18843-02	.26438+03	.10371-01	.44128+03	.00000	.00000	.14150+04	.56918+02
.3183	.82649-02	.21139+04	.19080-02	.28156+03	.99735-02	.48128+03	.00000	.00000	.13979+04	.34924+02
.3410	.84869-02	.21460+04	.19318-02	.29798+03	.95479-02	.52186+03	.00000	.00000	.13814+04	.12555+02

MAIN SHELL PART NO 5

.0000	.84869-02	.21460+04	.19318-02	.29798+03	.95479-02	.52186+03	.00000	.00000	.14280+04	.31504+02
.0111	.85914-02	.21616+04	.19433-02	.30604+03	.93503-02	.54169+03	.00000	.00000	.14199+04	.20345+02
.0221	.86938-02	.21772+04	.19549-02	.31394+03	.91466-02	.56165+03	.00000	.00000	.14120+04	.90998+01
.0332	.87939-02	.21928+04	.19665-02	.32166+03	.89368-02	.58176+03	.00000	.00000	.14043+04	.22301+01

.0332	.87939-02	.21928+04	.19665-02	.32166+03	.89368-02	.58176+03	.00000	.00000	.14043+04	.22301+01
.0443	.88916-02	.22085+04	.19782-02	.32923+03	.87209-02	.60200+03	.00000	.00000	.13967+04	.13645+02
.0553	.89869-02	.22241+04	.19898-02	.33664+03	.84988-02	.62239+03	.00000	.00000	.13893+04	.25145+02
.0664	.90797-02	.22397+04	.20015-02	.34389+03	.82705-02	.64291+03	.00000	.00000	.13821+04	.36730+02

.0664	.90797-02	.22397+04	.20015-02	.34389+03	.82705-02	.64291+03	.00000	.00000	.13821+04	.36730+02
.0775	.91699-02	.22553+04	.20131-02	.35100+03	.80359-02	.66358+03	.00000	.00000	.13750+04	.48400+02
.0885	.92575-02	.22709+04	.20248-02	.35796+03	.77951-02	.68438+03	.00000	.00000	.13680+04	.60155+02
.0996	.93424-02	.22865+04	.20365-02	.36478+03	.75478-02	.70532+03	.00000	.00000	.13612+04	.71994+02

.0996	.93424-02	.22865+04	.20365-02	.36478+03	.75478-02	.70532+03	.00000	.00000	.13612+04	.71994+02
.1107	.94245-02	.23021+04	.20482-02	.37146+03	.72942-02	.72641+03	.00000	.00000	.13545+04	.83918+02
.1217	.95038-02	.23177+04	.20599-02	.37801+03	.70341-02	.74763+03	.00000	.00000	.13480+04	.95926+02
.1328	.95802-02	.23333+04	.20717-02	.38443+03	.67676-02	.76899+03	.00000	.00000	.13415+04	.10802+03



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.1328	-.95802-02	-.23333+04	.20717-02	.38443+03	.67676-02	-.76899+03	.00000	.00000	.13416+04	-.10802+03
.1439	-.96536-02	-.23489+04	.20834-02	.39072+03	.64945-02	-.79050+03	.00000	.00000	.13353+04	-.12020+03
.1549	-.97239-02	-.23645+04	.20952-02	.39689+03	.62149-02	-.81214+03	.00000	.00000	.13291+04	-.13744+03
.1660	-.97911-02	-.23801+04	.21070-02	.40293+03	.59287-02	-.83393+03	.00000	.00000	.13230+04	-.14480+03

MAIN SHELL PART NO 6

.0000	.21070-02	.40293+03	.97911-02	.23801+04	.59287-02	-.83393+03	.00000	.00000	.17594+04	-.25018+03
.0033	.20874-02	.39695+03	.97957-02	.23801+04	.58015-02	-.83259+03	.00000	.00000	.16909+04	-.24978+03
.0067	.20683-02	.39083+03	.98003-02	.23801+04	.56745-02	-.83128+03	.00000	.00000	.16238+04	-.24938+03
.0100	.20496-02	.38459+03	.98049-02	.23801+04	.55476-02	-.82999+03	.00000	.00000	.15582+04	-.24900+03

.0100	.20496-02	.38459+03	.98049-02	.23802+04	.55468-02	-.83004+03	.00000	.00000	.15583+04	-.24901+03
.0133	.20313-02	.37821+03	.98095-02	.23802+04	.54202-02	-.82877+03	.00000	.00000	.14942+04	-.24863+03
.0167	.20135-02	.37171+03	.98142-02	.23802+04	.52937-02	-.82752+03	.00000	.00000	.14316+04	-.24826+03
.0200	.19960-02	.36509+03	.98188-02	.23802+04	.51675-02	-.82629+03	.00000	.00000	.13704+04	-.24789+03

.0200	.19960-02	.36511+03	.98188-02	.23803+04	.51673-02	-.82630+03	.00000	.00000	.13705+04	-.24789+03
.0233	.19790-02	.35837+03	.98235-02	.23803+04	.50413-02	-.82510+03	.00000	.00000	.13108+04	-.24753+03
.0267	.19624-02	.35151+03	.98281-02	.23803+04	.49154-02	-.82391+03	.00000	.00000	.12526+04	-.24717+03
.0300	.19462-02	.34455+03	.98328-02	.23803+04	.47897-02	-.82275+03	.00000	.00000	.11959+04	-.24683+03

.0300	.19462-02	.34455+03	.98328-02	.23803+04	.47896-02	-.82275+03	.00000	.00000	.11959+04	-.24683+03
.0333	.19305-02	.33747+03	.98375-02	.23803+04	.46641-02	-.82162+03	.00000	.00000	.11407+04	-.24649+03
.0367	.19151-02	.33029+03	.98422-02	.23803+04	.45387-02	-.82050+03	.00000	.00000	.10869+04	-.24615+03
.0400	.19002-02	.32300+03	.98469-02	.23803+04	.44136-02	-.81941+03	.00000	.00000	.10346+04	-.24582+03

.0400	.19002-02	.32300+03	.98469-02	.23803+04	.44136-02	-.81941+03	.00000	.00000	.10346+04	-.24582+03
.0433	.18857-02	.31561+03	.98516-02	.23803+04	.42889-02	-.81835+03	.00000	.00000	.98375+03	-.24550+03
.0467	.18716-02	.30813+03	.98563-02	.23803+04	.41637-02	-.81731+03	.00000	.00000	.93436+03	-.24519+03
.0500	.18580-02	.30055+03	.98610-02	.23803+04	.40390-02	-.81630+03	.00000	.00000	.88643+03	-.24489+03

MAIN SHELL PART NO 7

.0000	.98610-02	.23803+04	-.18580-02	-.30055+03	.40390-02	-.81630+03	.00000	.00000	.12528+03	-.33708+03
.0184	.97896-02	.23543+04	-.18392-02	-.30524+03	.37069-02	-.77775+03	.00000	.00000	.12998+03	-.31886+03
.0369	.97242-02	.23282+04	-.18204-02	-.31010+03	.33905-02	-.73952+03	.00000	.00000	.13483+03	-.30096+03
.0553	.96645-02	.23022+04	-.18017-02	-.31511+03	.30896-02	-.70159+03	.00000	.00000	.13985+03	-.28337+03

.0553	.96645-02	.23022+04	-.18017-02	-.31511+03	.30896-02	-.70159+03	.00000	.00000	.13985+03	-.28337+03
.0738	.96101-02	.22762+04	-.17829-02	-.32030+03	.28043-02	-.66397+03	.00000	.00000	.14504+03	-.26610+03
.0922	.95609-02	.22502+04	-.17642-02	-.32567+03	.25343-02	-.62665+03	.00000	.00000	.15041+03	-.24916+03
.1107	.95165-02	.22242+04	-.17455-02	-.33123+03	.22795-02	-.58962+03	.00000	.00000	.15597+03	-.23254+03

.1107	.95165-02	.22242+04	-.17455-02	-.33123+03	.22795-02	-.58962+03	.00000	.00000	.15597+03	-.23254+03
.1291	.94767-02	.21982+04	-.17268-02	-.33698+03	.20408-02	-.55288+03	.00000	.00000	.16172+03	-.21625+03
.1476	.94412-02	.21722+04	-.17082-02	-.34294+03	.18156-02	-.51643+03	.00000	.00000	.16768+03	-.20031+03
.1660	.94097-02	.21461+04	-.16895-02	-.34912+03	.16061-02	-.48027+03	.00000	.00000	.17386+03	-.18471+03

MAIN SHELL PART NO 8

.0000	.94097-02	.21461+04	-.16895-02	-.34912+03	.16061-02	-.48027+03	.00000	.00000	.22958+03	-.21428+03
.0228	.93746-02	.21140+04	-.16664-02	-.35791+03	.14715-02	-.43553+03	.00000	.00000	.23836+03	-.19595+03
.0456	.93425-02	.20818+04	-.16433-02	-.36710+03	.13501-02	-.39118+03	.00000	.00000	.24756+03	-.17817+03
.0683	.93130-02	.20497+04	-.16202-02	-.37673+03	.12420-02	-.34720+03	.00000	.00000	.25719+03	-.16098+03

.0683	.93130-02	.20497+04	-.16202-02	-.37673+03	.12420-02	-.34720+03	.00000	.00000	.25719+03	-.16098+03
.0911	.92858-02	.20175+04	-.15971-02	-.38682+03	.11470-02	-.30359+03	.00000	.00000	.26727+03	-.14438+03
.1139	.92607-02	.19854+04	-.15741-02	-.39739+03	.10652-02	-.26031+03	.00000	.00000	.27785+03	-.12838+03
.1367	.92372-02	.19532+04	-.15511-02	-.40849+03	.99632-03	-.21737+03	.00000	.00000	.28894+03	-.11302+03



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.1367	.92372-02	.19532+04	-.15511-02	-.40849+03	.99632-03	-.21737+03	.00000	.00000	.26894+03	-.11307+03
.1594	.92152-02	.19211+04	-.15281-02	-.42014+03	.94049-03	-.17473+03	.00000	.00000	.30060+03	-.98295+02
.1822	.91943-02	.18889+04	-.15052-02	-.43239+03	.89763-03	-.13238+03	.00000	.00000	.31284+03	-.84237+02
.2050	.91742-02	.18567+04	-.14823-02	-.44527+03	.86771-03	-.90295+02	.00000	.00000	.32572+03	-.70866+02
MAYN SHELL PART NO 9										
.0000	.14823-02	.44527+03	.91742-02	.18567+04	.86771-03	-.90295+02	.00000	.00000	.64504+03	-.27991+02
.0740	.17415-02	.27906+03	.92402-02	.18567+04	-.72443-02	-.63626+02	.00000	.00000	.97925+03	-.23416+02
.1479	.24812-02	.14884+03	.93279-02	.18567+04	-.12421-01	-.48097+02	.00000	.00000	.17998+04	-.28780+02
.2219	.35471-02	.61433+02	.94232-02	.18567+04	-.16186-01	-.40571+02	.00000	.00000	.25251+04	-.43135+02
.2219	.35464-02	.61459+02	.94233-02	.18567+04	-.16179-01	-.40567+02	.00000	.00000	.25244+04	-.43124+02
.2958	.48315-02	.11488+02	.95453-02	.18567+04	-.18157-01	-.38069+02	.00000	.00000	.31033+04	-.62141+02
.3698	.61298-02	-.16280+02	.97730-02	.18567+04	-.15778-01	-.38307+02	.00000	.00000	.32778+04	-.77078+02
.4437	.70415-02	-.29947+02	.10122-01	.18567+04	-.91157-02	-.40164+02	.00000	.00000	.36886+04	-.88860+02
.4437	.70312-02	-.30373+02	.10125-01	.18567+04	-.90296-02	-.40185+02	.00000	.00000	.36820+04	-.88304+02
.5177	.75211-02	-.27035+02	.10822-01	.18567+04	-.46178-02	-.42373+02	.00000	.00000	.38717+04	-.93590+02
.5917	.77681-02	-.18006+02	.10675-01	.18567+04	-.23678-02	-.44049+02	.00000	.00000	.39039+04	-.94679+02
.6656	.79077-02	-.94362+01	.10901-01	.18567+04	-.15921-02	-.45051+02	.00000	.00000	.38670+04	-.94278+02
.6656	.79092-02	-.93464+01	.10901-01	.18567+04	-.15952-02	-.45043+02	.00000	.00000	.38679+04	-.94300+02
.7396	.80242-02	-.33850+01	.11121-01	.18567+04	-.15981-02	-.45496+02	.00000	.00000	.38154+04	-.93153+02
.8135	.81527-02	-.16780-00	.11349-01	.18567+04	-.18990-02	-.45612+02	.00000	.00000	.37717+04	-.92121+02
.8875	.83056-02	.10493+01	.11579-01	.18567+04	-.22283-02	-.45570+02	.00000	.00000	.37437+04	-.91426+02
.8875	.83075-02	.11134+01	.11579-01	.18567+04	-.22384-02	-.45568+02	.00000	.00000	.37449+04	-.91454+02
.9615	.84828-02	.12571+01	.11826-01	.18567+04	-.24837-02	-.45476+02	.00000	.00000	.37312+04	-.91093+02
1.0354	.86724-02	.91611-00	.12087-01	.18567+04	-.26285-02	-.45394+02	.00000	.00000	.37267+04	-.90957+02
1.1094	.88697-02	.47413-00	.12360-01	.18567+04	-.26980-02	-.45342+02	.00000	.00000	.37270+04	-.90950+02
1.1094	.88709-02	.56902-00	.12360-01	.18567+04	-.26971-02	-.45333+02	.00000	.00000	.37277+04	-.90966+02
1.1833	.90711-02	.24909-00	.12644-01	.18567+04	-.27112-02	-.45303+02	.00000	.00000	.37298+04	-.91008+02
1.2573	.92718-02	.50130-01	.12940-01	.18567+04	-.27035-02	-.45293+02	.00000	.00000	.37319+04	-.91058+02
1.3312	.94709-02	-.47108-01	.13245-01	.18567+04	-.26910-02	-.45293+02	.00000	.00000	.37335+04	-.91093+02
1.3312	.94705-02	-.25757-01	.13246-01	.18567+04	-.26837-02	-.45288+02	.00000	.00000	.37332+04	-.91085+02
1.4052	.96683-02	-.83546-01	.13562-01	.18567+04	-.26672-02	-.45292+02	.00000	.00000	.37336+04	-.91094+02
1.4792	.98651-02	-.13665-00	.13888-01	.18567+04	-.26581-02	-.45300+02	.00000	.00000	.37334+04	-.91094+02
1.5531	.10062-01	-.20992-00	.14225-01	.18567+04	-.26607-02	-.45313+02	.00000	.00000	.37330+04	-.91087+02
1.5531	.10062-01	-.15712-00	.14225-01	.18567+04	-.26572-02	-.45306+02	.00000	.00000	.37332+04	-.91091+02
1.6271	.10259-01	-.23938-00	.14577-01	.18567+04	-.26675-02	-.45320+02	.00000	.00000	.37329+04	-.91087+02
1.7010	.10457-01	-.32074-00	.14928-01	.18567+04	-.26983-02	-.45341+02	.00000	.00000	.37334+04	-.91106+02
1.7750	.10659-01	-.32416-00	.15295-01	.18567+04	-.27559-02	-.45366+02	.00000	.00000	.37359+04	-.91174+02
1.7750	.10659-01	-.27275-00	.15295-01	.18567+04	-.27497-02	-.45358+02	.00000	.00000	.37360+04	-.91174+02
1.8490	.10865-01	-.62826-01	.15671-01	.18567+04	-.28224-02	-.45372+02	.00000	.00000	.37411+04	-.91304+02
1.9229	.11076-01	.38246-00	.16058-01	.18567+04	-.28983-02	-.45360+02	.00000	.00000	.37413+04	-.91305+02
1.9969	.11293-01	.69839-00	.16457-01	.18567+04	-.29427-02	-.45319+02	.00000	.00000	.37392+04	-.91242+02
1.9969	.11293-01	.75188-00	.16457-01	.18567+04	-.29355-02	-.45311+02	.00000	.00000	.37393+04	-.91241+02
2.0708	.11509-01	.95348-00	.16870-01	.18567+04	-.29083-02	-.45247+02	.00000	.00000	.37366+04	-.91157+02
2.1448	.11721-01	.95003-00	.17295-01	.18567+04	-.28056-02	-.45175+02	.00000	.00000	.37343+04	-.91019+02
2.2187	.11925-01	.10574+01	.17732-01	.18567+04	-.27304-02	-.45102+02	.00000	.00000	.37379+04	-.90862+02
2.2187	.11925-01	.11191+01	.17732-01	.18567+04	-.27231-02	-.45093+02	.00000	.00000	.37379+04	-.90861+02
2.2927	.12125-01	.13243+01	.18179-01	.18567+04	-.26935-02	-.45002+02	.00000	.00000	.37381+04	-.90616+02

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2.3667	.12325-01	.14958+01	.18636-01	.18567+04	-.27003-02	-.44898+02	.00000	.00000	.37370+04	-.90336+02
2.4400	.12525-01	.16034+01	.19104-01	.18567+04	-.27287-02	-.44783+02	.00000	.00000	.37359+04	-.90055+02
2.4406	.12525-01	.16652+01	.19105-01	.18567+04	-.27198-02	-.44773+02	.00000	.00000	.37359+04	-.90051+02
2.5146	.12728-01	.17170+01	.19585-01	.18567+04	-.27467-02	-.44647+02	.00000	.00000	.37350+04	-.89769+02
2.5885	.12932-01	.17290+01	.20076-01	.18567+04	-.27767-02	-.44520+02	.00000	.00000	.37345+04	-.89498+02
2.6625	.13138-01	.17313+01	.20579-01	.18567+04	-.28073-02	-.44392+02	.00000	.00000	.37346+04	-.89241+02
2.6625	.13138-01	.17894+01	.20580-01	.18567+04	-.27972-02	-.44381+02	.00000	.00000	.37345+04	-.89235+02
2.7365	.13346-01	.17912+01	.21095-01	.18567+04	-.28160-02	-.44249+02	.00000	.00000	.37345+04	-.88974+02
2.8104	.13554-01	.17943+01	.21622-01	.18567+04	-.28314-02	-.44116+02	.00000	.00000	.37345+04	-.88713+02
2.8844	.13764-01	.17934+01	.22161-01	.18567+04	-.28432-02	-.43984+02	.00000	.00000	.37344+04	-.88448+02
2.8844	.13764+01	.18524+01	.22162-01	.18567+04	-.28347-02	-.43974+02	.00000	.00000	.37343+04	-.88444+02
2.9583	.13974-01	.18153+01	.22713-01	.18567+04	-.28308-02	-.43838+02	.00000	.00000	.37332+04	-.88154+02
3.0323	.14183-01	.16836+01	.23277-01	.18567+04	-.28225-02	-.43708+02	.00000	.00000	.37309+04	-.87840+02
3.1062	.14391-01	.13938+01	.23853-01	.18567+04	-.28204-02	-.43593+02	.00000	.00000	.37275+04	-.87505+02
3.1062	.14392-01	.14000+01	.23853-01	.18567+04	-.28283-02	-.43595+02	.00000	.00000	.37281+04	-.87519+02
3.1802	.14602-01	.94892-00	.24440-01	.18567+04	-.28561-02	-.43507+02	.00000	.00000	.37248+04	-.87194+02
3.2542	.14816-01	.34763-00	.25038-01	.18567+04	-.29441-02	-.43459+02	.00000	.00000	.37231+04	-.86920+02
3.3281	.15040-01	-.21489-00	.25646-01	.18567+04	-.31344-02	-.43455+02	.00000	.00000	.37269+04	-.86787+02
3.3281	.15040-01	-.15308-00	.25647-01	.18567+04	-.31242-02	-.43444+02	.00000	.00000	.37268+04	-.86780+02
3.4021	.15282-01	-.25370-00	.26264-01	.18567+04	-.34400-02	-.43464+02	.00000	.00000	.37409+04	-.86891+02
3.4760	.15552-01	.87070-00	.26890-01	.18567+04	-.38902-02	-.43452+02	.00000	.00000	.37719+04	-.87383+02
3.5500	.15859-01	.43105+01	.27527-01	.18567+04	-.43854-02	-.43278+02	.00000	.00000	.38244+04	-.88319+02
3.5500	.15859-01	.43439+01	.27527-01	.18567+04	-.43851-02	-.43274+02	.00000	.00000	.38247+04	-.88323+02
3.6240	.16196-01	.11283+02	.28179-01	.18567+04	-.46689-02	-.42721+02	.00000	.00000	.38958+04	-.89564+02
3.6979	.16533-01	.22171+02	.28858-01	.18567+04	-.42578-02	-.41506+02	.00000	.00000	.39612+04	-.90465+02
3.7719	.16791-01	.35622+02	.29581-01	.18567+04	-.24126-02	-.39375+02	.00000	.00000	.39770+04	-.89950+02
3.7719	.16791-01	.35680+02	.29581-01	.18567+04	-.24030-02	-.39364+02	.00000	.00000	.39769+04	-.89943+02
3.8458	.16831-01	.46711+02	.30371-01	.18567+04	-.17669-02	-.36276+02	.00000	.00000	.38566+04	-.86040+02
3.9198	.16486-01	.53592+02	.31190-01	.18567+04	.68238-02	-.32644+02	.00000	.00000	.40146+04	-.78387+02
3.9937	.15934-01	.74472+02	.31909-01	.18567+04	.77147-02	-.27954+02	.00000	.00000	.41483+04	-.62308+02
3.9937	.15983-01	.77089+02	.31898-01	.18567+04	.73392-02	-.27792+02	.00000	.00000	.41929+04	-.62989+02
4.0677	.15447-01	.10026+03	.32602-01	.18567+04	.70976-02	-.21190+02	.00000	.00000	.40653+04	-.42225+02
4.1417	.14936-01	.10880+03	.33318-01	.18567+04	.67463-02	-.13313+02	.00000	.00000	.35904+04	-.23711+02
4.2156	.14431-01	.75467+02	.34061-01	.18567+04	.70455-02	-.61855+01	.00000	.00000	.26772+04	-.15637+02
4.2156	.14430-01	.75089+02	.34062-01	.18567+04	.70617-02	-.62147+01	.00000	.00000	.26753+04	-.15633+02
4.2896	.13875-01	-.10361+02	.34835-01	.18567+04	.79830-02	-.34901+01	.00000	.00000	.17103+04	-.25431+01
4.3635	.13252-01	-.15166+03	.35635-01	.18567+04	.87758-02	-.91243+01	.00000	.00000	.67033+03	-.34738+01
4.4375	.12611-01	-.35169+03	.36455-01	.18567+04	.81800-02	-.27377+02	.00000	.00000	-.38012+03	-.21216+01
MAIN SHELL PART NO 10										
1.5708	.12611-01	-.35162+03	.36454-01	.18567+04	.81814-02	-.27365+02	.00000	.00000	-.38021+03	-.21177+01
1.6134	.14048-01	-.31397+03	.36035-01	.18714+04	.78042-02	-.31780+02	.00000	.00000	-.50029+03	-.27725+01
1.6559	.15471-01	-.27718+03	.35555-01	.18855+04	.73376-02	-.35731+02	.00000	.00000	-.61570+03	-.33028+01
1.6559	.15471-01	-.27718+03	.35555-01	.18855+04	.73376-02	-.35731+02	.00000	.00000	-.61570+03	-.33028+01
1.6985	.16878-01	-.24136+03	.35016-01	.18993+04	.67884-02	-.39244+02	.00000	.00000	-.72551+03	-.37178+01
1.7410	.18268-01	-.20663+03	.34419-01	.19129+04	.61617-02	-.42342+02	.00000	.00000	-.82879+03	-.40254+01
1.7410	.18268-01	-.20663+03	.34419-01	.19129+04	.61616-02	-.42342+02	.00000	.00000	-.82878+03	-.40254+01
1.7836	.19638-01	-.17312+03	.33766-01	.19265+04	.54616-02	-.45041+02	.00000	.00000	-.92458+03	-.42332+01

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1.8262	.20989-01	-.14092+03	.33058-01	.19404+04	.46915-02	-.47358+02	.00000	.00000	-.10119+04	-.43462+01
1.8262	.20989-01	-.14093+03	.33058-01	.19404+04	.46914-02	-.47358+02	.00000	.00000	-.10119+04	-.43462+01
1.8687	.22318-01	-.11017+03	.32298-01	.19548+04	.38536-02	-.49303+02	.00000	.00000	-.10896+04	-.45773+01
1.9113	.23625-01	-.80973+02	.31486-01	.19698+04	.29499-02	-.50887+02	.00000	.00000	-.11565+04	-.43276+01
1.9113	.23625-01	-.80974+02	.31486-01	.19698+04	.29499-02	-.50887+02	.00000	.00000	-.11565+04	-.43276+01
1.9538	.24909-01	-.53432+02	.30625-01	.19859+04	.19819-02	-.52116+02	.00000	.00000	-.12112+04	-.42904+01
1.9964	.26169-01	-.27649+02	.29716-01	.20032+04	.95064-03	-.52996+02	.00000	.00000	-.12522+04	-.40218+01
1.9964	.26169-01	-.27650+02	.29716-01	.20032+04	.95060-03	-.52996+02	.00000	.00000	-.12522+04	-.40217+01
2.0390	.27407-01	-.37171+01	.28762-01	.20222+04	-.14272-03	-.53529+02	.00000	.00000	-.12777+04	-.37826+01
2.0815	.28623-01	-.18288+02	.27765-01	.20430+04	-.12969-02	-.53716+02	.00000	.00000	-.12855+04	-.34991+01
2.0815	.28623-01	-.18286+02	.27765-01	.20430+04	-.12970-02	-.53716+02	.00000	.00000	-.12855+04	-.34991+01
2.1241	.29818-01	-.38304+02	.26728-01	.20662+04	-.25105-02	-.53559+02	.00000	.00000	-.12734+04	-.31830+01
2.1666	.30994-01	-.56303+02	.25652-01	.20920+04	-.37811-02	-.53053+02	.00000	.00000	-.12385+04	-.28478+01
2.1666	.30994-01	-.56301+02	.25652-01	.20920+04	-.37811-02	-.53053+02	.00000	.00000	-.12385+04	-.28478+01
2.2092	.32154-01	-.72282+02	.24540-01	.21208+04	-.51055-02	-.52195+02	.00000	.00000	-.11777+04	-.25096+01
2.2518	.33302-01	-.86297+02	.23394-01	.21530+04	-.64787-02	-.50977+02	.00000	.00000	-.10873+04	-.21669+01
2.2518	.33302-01	-.86294+02	.23394-01	.21530+04	-.64788-02	-.50977+02	.00000	.00000	-.10873+04	-.21668+01
2.2943	.34442-01	-.98458+02	.22218-01	.21887+04	-.78937-02	-.49389+02	.00000	.00000	-.96310+03	-.19008+01
2.3369	.35581-01	-.10897+03	.21014-01	.22281+04	-.93399-02	-.47413+02	.00000	.00000	-.80035+03	-.16756+01
2.3369	.35581-01	-.10896+03	.21014-01	.22281+04	-.93401-02	-.47412+02	.00000	.00000	-.80036+03	-.16753+01
2.3794	.36726-01	-.11814+03	.19785-01	.22712+04	-.10802-01	-.45019+02	.00000	.00000	-.59364+03	-.15374+01
2.4220	.37885-01	-.12644+03	.18534-01	.23177+04	-.12259-01	-.42164+02	.00000	.00000	-.33693+03	-.15147+01
2.4220	.37885-01	-.12643+03	.18534-01	.23177+04	-.12259-01	-.42163+02	.00000	.00000	-.33695+03	-.15143+01
2.4646	.39068-01	-.13451+03	.17263-01	.23666+04	-.13678-01	-.38772+02	.00000	.00000	-.23714+02	-.16343+01
2.5071	.40284-01	-.14325+03	.15975-01	.24164+04	-.15012-01	-.34725+02	.00000	.00000	-.35288+03	-.19200+01
2.5071	.40284-01	-.14322+03	.15975-01	.24164+04	-.15013-01	-.34725+02	.00000	.00000	-.35280+03	-.19189+01
2.5497	.41544-01	-.15383+03	.14674-01	.24643+04	-.16192-01	-.29830+02	.00000	.00000	-.79941+03	-.23839+01
2.5922	.42855-01	-.16783+03	.13362-01	.25059+04	-.17109-01	-.23777+02	.00000	.00000	-.13215+04	-.30218+01
2.5922	.42855-01	-.16776+03	.13362-01	.25060+04	-.17110-01	-.23776+02	.00000	.00000	-.13212+04	-.30194+01
2.6348	.44217-01	-.18709+03	.12043-01	.25344+04	-.17598-01	-.16077+02	.00000	.00000	-.19211+04	-.37930+01
2.6774	.45618-01	-.21403+03	.10720-01	.25390+04	-.17394-01	-.59626+01	.00000	.00000	-.25943+04	-.46141+01
2.6774	.45618-01	-.21387+03	.10721-01	.25393+04	-.17396-01	-.59630+01	.00000	.00000	-.25936+04	-.46080+01
2.7199	.47018-01	-.25085+03	.93993-02	.25047+04	-.16074-01	-.77363+01	.00000	.00000	-.33222+04	-.53258+01
2.7625	.48327-01	-.29994+03	.80880-02	.24094+04	-.12948-01	-.26796+02	.00000	.00000	-.40617+04	-.57128+01
2.7625	.48326-01	-.29957+03	.80888-02	.24103+04	-.12953-01	-.26791+02	.00000	.00000	-.40597+04	-.56969+01
2.8050	.49361-01	-.36118+03	.68030-02	.22264+04	-.69031-02	-.53755+02	.00000	.00000	-.47148+04	-.55063+01
2.8476	.49773-01	-.43150+03	.55718-02	.19245+04	-.38774-02	-.92240+02	.00000	.00000	-.50947+04	-.46305+01
MAIN SHELL PART NO 11										
.0000	.24717-01	-.13070+04	.43555-01	.14804+04	.38690-02	.92220+02	.00000	.00000	-.99814+04	-.11301+03
.0529	.24497-01	-.82670+03	.44061-01	.12875+04	.43845-02	.35493+02	.00000	.00000	-.82785+04	-.67989+02
.0529	.24497-01	-.82670+03	.44061-01	.12875+04	.43844-02	.35493+02	.00000	.00000	-.82785+04	-.67989+02
.1058	.24260-01	-.44311+03	.44575-01	.11282+04	.45163-02	.14475+01	.00000	.00000	-.66377+04	-.36237+02
.1058	.24260-01	-.44313+03	.44575-01	.11282+04	.45162-02	.14473+01	.00000	.00000	-.66377+04	-.36237+02
.1588	.24026-01	-.15516+03	.45095-01	.10020+04	.42408-02	-.14845+02	.00000	.00000	-.51608+04	-.15900+02



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.1588	.24026-01	-.15519+03	.45095-01	.10021+04	.42407-02	-.14845+02	.00000	.00000	.51607+04	.15899+02
.2117	.23818-01	.45283+02	.45622-01	.90616+03	.35640-02	-.18120+02	.00000	.00000	.39194+04	.46130+01
.2117	.23818-01	.45283+02	.45622-01	.90617+03	.35640-02	-.18121+02	.00000	.00000	.39194+04	.46128+01
.2646	.23654-01	.17142+03	.46154-01	.83600+03	.25939-02	-.12582+02	.00000	.00000	.29417+04	-.18111-00
.2646	.23654-01	.17141+03	.46154-01	.83601+03	.25939-02	-.12582+02	.00000	.00000	.29417+04	-.18123-00
.3175	.23541-01	.23774+03	.46689-01	.78654+03	.18222-02	-.17098+01	.00000	.00000	.21898+04	-.83092-00

MAIN SHELL PART NO 12

.0000	.69493-02	-.33015+02	.51824-01	.82102+03	.18223-02	-.17101+01	.00000	.00000	.20915+04	-.51307-00
.0739	.68350-02	.10461+01	.52587-01	.82102+03	.12191-02	-.27122+01	.00000	.00000	.18558+04	-.81367-00
.1478	.67691-02	.12168+02	.53345-01	.82102+03	.59995-03	-.21204+01	.00000	.00000	.17186+04	-.63613-00
.2217	.67415-02	.11664+02	.54108-01	.82102+03	.18741-03	-.11971+01	.00000	.00000	.16613+04	-.35917-00
.2217	.67415-02	.11667+02	.54108-01	.82102+03	.18718-03	-.11971+01	.00000	.00000	.16614+04	-.35912-00
.2956	.67363-02	.73086+01	.54872-01	.82102+03	-.16112-04	-.48803-00	.00000	.00000	.16505+04	-.14641-00
.3694	.67406-02	.30420+01	.55637-01	.82102+03	-.84388-04	-.11253+00	.00000	.00000	.16594+04	-.33758-01
.4433	.67473-02	.27333-00	.56400-01	.82102+03	-.94247-04	-.69803-03	.00000	.00000	.16734+04	-.20941-03
.4433	.67461-02	.39914-00	.56400-01	.82102+03	-.75104-04	.54071-01	.00000	.00000	.16708+04	.16221-01
.5172	.67512-02	-.11453+01	.57164-01	.82102+03	-.63684-04	.18576-01	.00000	.00000	.16813+04	.55727-02
.5911	.67560-02	-.14400+01	.57928-01	.82102+03	-.71501-04	-.85197-01	.00000	.00000	.16914+04	-.25559-01
.6650	.67624-02	-.38872-00	.58691-01	.82102+03	-.10413-03	-.16346-00	.00000	.00000	.17045+04	-.49037-01
.6650	.67631-02	-.50195-00	.58691-01	.82102+03	-.11596-03	-.19986-00	.00000	.00000	.17060+04	-.59957-01
.7389	.67734-02	.28621+01	.59454-01	.82102+03	-.16209-03	-.12897-00	.00000	.00000	.17275+04	-.38691-01
.8128	.67857-02	.91904+01	.60216-01	.82102+03	-.15087-03	.29700-00	.00000	.00000	.17528+04	.89101-01
.8867	.67915-02	.18090+02	.60979-01	.82102+03	.33870-04	.12953+01	.00000	.00000	.17649+04	.38860-00
.8867	.67921-02	.17994+02	.60979-01	.82102+03	.24158-04	.12652+01	.00000	.00000	.17661+04	.37957-00
.9606	.67741-02	.25999+02	.61741-01	.82102+03	.53315-03	.29183+01	.00000	.00000	.17288+04	.87549-00
1.0344	.67017-02	.23234+02	.62505-01	.82102+03	.15053-02	.48500+01	.00000	.00000	.15790+04	.14550+01
1.1083	.65417-02	-.84977+01	.63273-01	.82102+03	.28618-02	.56452+01	.00000	.00000	.12476+04	.16936+01
1.1083	.65424-02	-.85923+01	.63273-01	.82102+03	.28505-02	.56114+01	.00000	.00000	.12491+04	.16834+01
1.1822	.62857-02	-.93556+02	.64049-01	.82102+03	.39594-02	.22413+01	.00000	.00000	.71762+03	.67240-00
1.2561	.60013-02	-.25025+03	.64835-01	.82102+03	.32320-02	-.10010+02	.00000	.00000	.12873+03	-.30030+01
1.3300	.59229-02	-.46047+03	.65629-01	.82102+03	-.21950-02	-.36135+02	.00000	.00000	-.33634+02	-.10841+02

MAIN SHELL PART NO 13

.0000	.62838-01	.57997+03	.19841-01	.74147+03	-.22033-02	-.36158+02	.00000	.00000	-.32381+03	-.39695+01
.0484	.62959-01	.47521+03	.20345-01	.82453+03	-.27238-02	-.12633+02	.00000	.00000	-.24893+03	.84359+01
.0484	.62959-01	.47521+03	.20345-01	.82453+03	-.27239-02	-.12633+02	.00000	.00000	-.24892+03	.84360+01
.0968	.63095-01	.36815+03	.20849-01	.91222+03	-.28394-02	.63686+01	.00000	.00000	-.99433+02	.19901+02
.0968	.63095-01	.36815+03	.20849-01	.91222+03	-.28394-02	.63686+01	.00000	.00000	-.99428+02	.19901+02
.1452	.63231-01	.26098+03	.21352-01	.99910+03	-.27652-02	.20552+02	.00000	.00000	.11841+03	.30572+02
.1452	.63231-01	.26097+03	.21352-01	.99912+03	-.27651-02	.20553+02	.00000	.00000	.11839+03	.30571+02
.1936	.63362-01	.15671+03	.21854-01	.10776+04	-.26225-02	.29617+02	.00000	.00000	.40877+03	.40852+02
.1936	.63362-01	.15670+03	.21854-01	.10776+04	-.26224-02	.29619+02	.00000	.00000	.40875+03	.40851+02
.2420	.63485-01	.60347+02	.22355-01	.11352+04	-.24811-02	.33228+02	.00000	.00000	.79009+03	.51565+02
.2420	.63485-01	.60336+02	.22355-01	.11353+04	-.24809-02	.33231+02	.00000	.00000	.79007+03	.51564+02

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.2905	.54222-01	.18983-01	.00000	-.10597-02	-.32906+02	.64219+04	-.30752+04	.10324+05	.00000	.00000
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MAIN SHELL PART NO 14

.0000	.57349-01	-.33930-02	.00000	-.10595-02	-.26041+03	.61962+04	-.36230+04	.10736+05	.00000	.00000
.0233	.57373-01	-.31563-02	.00000	-.10434-02	-.10156+04	.68595+04	-.41555+04	.11360+05	.00000	.00000
.0466	.57397-01	-.29198-02	.00000	-.10215-02	-.16793+04	.74080+04	-.46653+04	.11985+05	.00000	.00000
.0466	.57397-01	-.29198-02	.00000	-.10215-02	-.16794+04	.74082+04	-.46653+04	.11985+05	.00000	.00000
.0699	.57421-01	-.26832-02	.00000	-.99501-03	-.22431+04	.78248+04	-.51590+04	.12626+05	.00000	.00000
.0932	.57444-01	-.24468-02	.00000	-.96554-03	-.26943+04	.80839+04	-.56469+04	.13306+05	.00000	.00000
.0932	.57444-01	-.24468-02	.00000	-.96554-03	-.26943+04	.80839+04	-.56469+04	.13306+05	.00000	.00000
.1165	.57466-01	-.22106-02	.00000	-.93493-03	-.30136+04	.81458+04	-.61452+04	.14062+05	.00000	.00000
.1398	.57487-01	-.19745-02	.00000	-.90564-03	-.31696+04	.79458+04	-.66813+04	.14954+05	.00000	.00000
.1398	.57487-01	-.19745-02	.00000	-.90565-03	-.31694+04	.79458+04	-.66812+04	.14954+05	.00000	.00000
.1631	.57508-01	-.17387-02	.00000	-.88109-03	-.31087+04	.73727+04	-.73028+04	.16088+05	.00000	.00000
.1864	.57528-01	-.15033-02	.00000	-.86641-03	-.27332+04	.62217+04	-.80994+04	.17660+05	.00000	.00000
.1864	.57528-01	-.15033-02	.00000	-.86643-03	-.27327+04	.62213+04	-.80994+04	.17660+05	.00000	.00000
.2097	.57548-01	-.12685-02	.00000	-.87012-03	-.18458+04	.40766+04	-.92554+04	.20072+05	.00000	.00000
.2330	.57569-01	-.10347-02	.00000	-.90783-03	-.11836+01	.82422+00	-.11196+05	.24246+05	.00000	.00000



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DEFLECTIONS AND STRESSES FOR WAVE NUMBER NX= 0 2810 PSI PLUS TEMPERATURE LOADING

X	W	UPHI	UTHETA	BPHI	SPHI IN	SPHI OUT	STHETA IN	STHETA OUT	SFITH IN	SFITH OUT
MAIN SHELL PART NO 1										
.0000	.00000	.00000	.00000	.00000	.16659+06	-.11458+06	.18269+05	-.66081+05	.00000	.00000
.0250	.40093-04	.82967-04	.00000	-.31340-02	.14530+06	-.91699+05	.12884+05	-.58215+05	.00000	.00000
.0500	.15302-03	.15953-03	.00000	-.58263-02	.12507+06	-.69778+05	.96358+04	-.48818+05	.00000	.00000
.0500	.15302-03	.15953-03	.00000	-.58263-02	.12507+06	-.69778+05	.96358+04	-.48818+05	.00000	.00000
.0750	.32772-03	.23014-03	.00000	-.80763-02	.10604+06	-.48944+05	.82899+04	-.38204+05	.00000	.00000
.1000	.55317-03	.29534-03	.00000	-.98862-02	.88281+05	-.29265+05	.85949+04	-.26669+05	.00000	.00000
.1000	.55318-03	.29534-03	.00000	-.98863-02	.88280+05	-.29264+05	.85947+04	-.26669+05	.00000	.00000
.1250	.81841-03	.35576-03	.00000	-.11260-01	.71833+05	-.10759+05	.10286+05	-.14492+05	.00000	.00000
.1500	.11126-02	.41207-03	.00000	-.12201-01	.56673+05	.66067+04	.13086+05	-.19341+04	.00000	.00000
.1500	.11126-02	.41207-03	.00000	-.12202-01	.56671+05	.66081+04	.13086+05	-.19334+04	.00000	.00000
.1750	.14249-02	.46502-03	.00000	-.12714-01	.42736+05	.22915+05	.16707+05	.10760+05	.00000	.00000
.2000	.17447-02	.51541-03	.00000	-.12798-01	.29923+05	.38284+05	.20851+05	.23360+05	.00000	.00000
.2000	.17447-02	.51541-03	.00000	-.12798-01	.29923+05	.38284+05	.20851+05	.23360+05	.00000	.00000
.2250	.20612-02	.56412-03	.00000	-.12451-01	.18106+05	.52864+05	.25213+05	.35640+05	.00000	.00000
.2500	.23636-02	.61209-03	.00000	-.11663-01	.71390+04	.66828+05	.29475+05	.47381+05	.00000	.00000
MAIN SHELL PART NO 2										
.0000	.23636-02	.61209-03	.00000	-.11663-01	.71378+04	.66829+05	.29474+05	.47382+05	.00000	.00000
.2241	.78531-02	.98976-03	.00000	-.22677-02	.16286+05	.57680+05	.69426+05	.81844+05	.00000	.00000
.4482	.39331-02	.13306-02	.00000	.56857-03	.35606+05	.38361+05	.77220+05	.78047+05	.00000	.00000
.4482	.39364-02	.13305-02	.00000	.54791-03	.35631+05	.38336+05	.77309+05	.78121+05	.00000	.00000
.6723	.38275-02	.16751-02	.00000	.29573-03	.38414+05	.35553+05	.75425+05	.74567+05	.00000	.00000
.8964	.37978-02	.20236-02	.00000	.28222-04	.37332+05	.36635+05	.74357+05	.74148+05	.00000	.00000
.8964	.38014-02	.20235-02	.00000	.57514-05	.37357+05	.36610+05	.74454+05	.74230+05	.00000	.00000
1.1205	.38045-02	.23723-02	.00000	-.58412-05	.36798+05	.37169+05	.74365+05	.74476+05	.00000	.00000
1.3446	.37977-02	.27211-02	.00000	.66790-04	.36801+05	.37166+05	.74197+05	.74306+05	.00000	.00000
1.3446	.38022-02	.27210-02	.00000	.38703-04	.36833+05	.37134+05	.74319+05	.74409+05	.00000	.00000
1.5687	.37937-02	.30701-02	.00000	-.31602-05	.37651+05	.36316+05	.74352+05	.73951+05	.00000	.00000
1.7928	.38404-02	.34186-02	.00000	-.52890-03	.39824+05	.34142+05	.76170+05	.74466+05	.00000	.00000
1.7928	.38441-02	.34185-02	.00000	-.55168-03	.39849+05	.34118+05	.76269+05	.74549+05	.00000	.00000
2.0169	.40553-02	.37596-02	.00000	-.11003-02	.34741+05	.39226+05	.80013+05	.81358+05	.00000	.00000
2.2410	.39215-02	.40926-02	.00000	.41867-02	-.24142+04	.76381+05	.65524+05	.89162+05	.00000	.00000
MAIN SHELL PART NO 3										
.0000	.39260-02	.40925-02	.00000	.41586-02	-.23826+04	.76349+05	.65646+05	.89265+05	.00000	.00000
.0250	.38058-02	.41298-02	.00000	.54390-02	-.22507+04	.73221+05	.62683+05	.85325+05	.00000	.00000
.0500	.36549-02	.41658-02	.00000	.66213-02	-.22827+04	.70490+05	.58903+05	.80735+05	.00000	.00000
.0500	.36549-02	.41658-02	.00000	.66213-02	-.22827+04	.70490+05	.58903+05	.80735+05	.00000	.00000
.0750	.34754-02	.42009-02	.00000	.77197-02	-.23656+04	.68017+05	.54396+05	.75511+05	.00000	.00000
.1000	.32695-02	.42355-02	.00000	.87428-02	-.23586+04	.65638+05	.49254+05	.69653+05	.00000	.00000
.1000	.32695-02	.42355-02	.00000	.87429-02	-.23590+04	.65639+05	.49254+05	.69653+05	.00000	.00000

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.1250	.30389-02	.42699-02	.00000	.96938-02	-.21049+04	.63178+05	.43570+05	.63155+05	.00000	.00000
.1500	.27854-02	.43045-02	.00000	.10570-01	-.14357+04	.60452+05	.37439+05	.56006+05	.00000	.00000
.1500	.27854-02	.43045-02	.00000	.10571-01	-.14360+04	.60452+05	.37439+05	.56006+05	.00000	.00000
.1750	.25110-02	.43397-02	.00000	.11366-01	-.18103+03	.57274+05	.30962+05	.48198+05	.00000	.00000
.2000	.22179-02	.43758-02	.00000	.12071-01	-.18310+04	.53460+05	.24242+05	.39731+05	.00000	.00000
.2000	.22179-02	.43758-02	.00000	.12071-01	.18310+04	.53460+05	.24242+05	.39731+05	.00000	.00000
.2250	.19083-02	.44133-02	.00000	.12671-01	.47674+04	.48832+05	.17392+05	.30611+05	.00000	.00000
.2500	.15853-02	.44528-02	.00000	.13149-01	.87891+04	.43219+05	.10530+05	.20858+05	.00000	.00000

MAIN SHELL PART NO 4

.0000	-.44528-02	.15853-02	.00000	.13149-01	-.36076+04	.31034+04	-.29647+05	.45281+05	.00000	.00000
.0227	-.47510-02	.16076-02	.00000	.13083-01	.53040+03	-.73568+03	-.27739+05	.43074+05	.00000	.00000
.0455	-.50475-02	.16300-02	.00000	.12994-01	.47256+04	-.46483+04	-.25773+05	.40825+05	.00000	.00000
.0682	-.53416-02	.16526-02	.00000	.12881-01	.89792+04	-.86344+04	-.23749+05	.38534+05	.00000	.00000
.0682	-.53416-02	.16526-02	.00000	.12881-01	.89792+04	-.86344+04	-.23749+05	.38534+05	.00000	.00000
.0909	-.56329-02	.16753-02	.00000	.12744-01	.13292+05	-.12694+05	-.21669+05	.36201+05	.00000	.00000
.1137	-.59209-02	.16981-02	.00000	.12583-01	.17665+05	-.16827+05	-.19534+05	.33826+05	.00000	.00000
.1364	-.62049-02	.17210-02	.00000	.12397-01	.22100+05	-.21033+05	-.17345+05	.31408+05	.00000	.00000
.1364	-.62049-02	.17210-02	.00000	.12397-01	.22100+05	-.21033+05	-.17345+05	.31408+05	.00000	.00000
.1591	-.64843-02	.17441-02	.00000	.12186-01	.26596+05	-.25313+05	-.15102+05	.28948+05	.00000	.00000
.1819	-.67587-02	.17672-02	.00000	.11949-01	.31155+05	-.29666+05	-.12806+05	.26446+05	.00000	.00000
.2046	-.70274-02	.17905-02	.00000	.11687-01	.35778+05	-.34093+05	-.10458+05	.23902+05	.00000	.00000
.2046	-.70274-02	.17905-02	.00000	.11687-01	.35778+05	-.34093+05	-.10458+05	.23902+05	.00000	.00000
.2273	-.72899-02	.18138-02	.00000	.11398-01	.40464+05	-.38592+05	-.80579+04	.21316+05	.00000	.00000
.2501	-.75455-02	.18372-02	.00000	.11083-01	.45215+05	-.43165+05	-.56073+04	.18687+05	.00000	.00000
.2728	-.77936-02	.18607-02	.00000	.10741-01	.50032+05	-.47812+05	-.31063+04	.16016+05	.00000	.00000
.2728	-.77936-02	.18607-02	.00000	.10741-01	.50032+05	-.47812+05	-.31063+04	.16016+05	.00000	.00000
.2955	-.80334-02	.18843-02	.00000	.10371-01	.54913+05	-.52532+05	-.55542+03	.13303+05	.00000	.00000
.3183	-.82649-02	.19080-02	.00000	.99735-02	.59861+05	-.57324+05	.20449+04	.10548+05	.00000	.00000
.3410	-.84869-02	.19318-02	.00000	.95479-02	.64875+05	-.62191+05	.46942+04	.77512+04	.00000	.00000

MAIN SHELL PART NO 5

.0000	-.84869-02	.19318-02	.00000	.95479-02	.60486+05	-.57895+05	.26354+04	.97819+04	.00000	.00000
.0111	-.85914-02	.19433-02	.00000	.93503-02	.62770+05	-.60108+05	.38661+04	.84811+04	.00000	.00000
.0221	-.86938-02	.19549-02	.00000	.91466-02	.65088+05	-.62339+05	.51072+04	.71714+04	.00000	.00000
.0332	-.87939-02	.19665-02	.00000	.89368-02	.67382+05	-.64585+05	.63586+04	.58528+04	.00000	.00000
.0332	-.87939-02	.19665-02	.00000	.89368-02	.67382+05	-.64585+05	.63586+04	.58528+04	.00000	.00000
.0443	-.88916-02	.19782-02	.00000	.87209-02	.69712+05	-.66849+05	.76205+04	.45252+04	.00000	.00000
.0553	-.89869-02	.19898-02	.00000	.84988-02	.72056+05	-.69129+05	.88926+04	.31886+04	.00000	.00000
.0664	-.90797-02	.20015-02	.00000	.82705-02	.74415+05	-.71425+05	.10175+05	.18431+04	.00000	.00000
.0664	-.90797-02	.20015-02	.00000	.82705-02	.74415+05	-.71425+05	.10175+05	.18431+04	.00000	.00000
.0775	-.91699-02	.20131-02	.00000	.80359-02	.76790+05	-.73738+05	.11468+05	.08855+03	.00000	.00000
.0885	-.92575-02	.20248-02	.00000	.77951-02	.79180+05	-.76067+05	.12771+05	.07494+03	.00000	.00000
.0996	-.93424-02	.20365-02	.00000	.75478-02	.81585+05	-.78413+05	.14084+05	.22474+04	.00000	.00000
.0996	-.93424-02	.20365-02	.00000	.75478-02	.81585+05	-.78413+05	.14084+05	.22474+04	.00000	.00000
.1107	-.94245-02	.20482-02	.00000	.72942-02	.84005+05	-.80775+05	.15407+05	.36289+04	.00000	.00000
.1217	-.95038-02	.20599-02	.00000	.70341-02	.86441+05	-.83154+05	.16741+05	.50194+04	.00000	.00000
.1328	-.95802-02	.20717-02	.00000	.67676-02	.88892+05	-.85549+05	.18085+05	.64189+04	.00000	.00000

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.1328	-.95802-02	.20717-02	.00000	.67676-02	.88892+05	-.85549+05	.18085+05	-.64189+04	.00000	.00000
.1439	-.96536-02	.20834-02	.00000	.64945-02	.91358+05	-.87961+05	.19438+05	-.78274+04	.00000	.00000
.1549	-.97239-02	.20952-02	.00000	.62149-02	.93840+05	-.90389+05	.20802+05	-.92450+04	.00000	.00000
.1660	-.97911-02	.21070-02	.00000	.59287-02	.96337+05	-.92833+05	.22176+05	-.10672+05	.00000	.00000

MAIN SHELL PART NO 6

.0000	.21070-02	.97911-02	.00000	.59287-02	.13699+06	-.11319+06	.46324+05	-.28730+05	.00000	.00000
.0033	.20874-02	.97957-02	.00000	.58015-02	.13679+06	-.11299+06	.45921+05	-.29012+05	.00000	.00000
.0067	.20683-02	.98003-02	.00000	.56745-02	.13659+06	-.11279+06	.45527+05	-.29289+05	.00000	.00000
.0100	.20496-02	.98049-02	.00000	.55476-02	.13640+06	-.11260+06	.45141+05	-.29558+05	.00000	.00000

.0100	.20496-02	.98049-02	.00000	.55468-02	.13641+06	-.11261+06	.45143+05	-.29561+05	.00000	.00000
.0133	.20313-02	.98095-02	.00000	.54202-02	.13622+06	-.11241+06	.44766+05	-.29824+05	.00000	.00000
.0167	.20135-02	.98142-02	.00000	.52937-02	.13603+06	-.11223+06	.44396+05	-.30081+05	.00000	.00000
.0200	.19960-02	.98188-02	.00000	.51675-02	.13585+06	-.11204+06	.44035+05	-.30331+05	.00000	.00000

.0200	.19960-02	.98188-02	.00000	.51673-02	.13585+06	-.11204+06	.44036+05	-.30331+05	.00000	.00000
.0233	.19790-02	.98235-02	.00000	.50413-02	.13567+06	-.11186+06	.43683+05	-.30575+05	.00000	.00000
.0267	.19624-02	.98281-02	.00000	.49154-02	.13549+06	-.11169+06	.43339+05	-.30813+05	.00000	.00000
.0300	.19462-02	.98328-02	.00000	.47897-02	.13531+06	-.11151+06	.43004+05	-.31044+05	.00000	.00000

.0300	.19462-02	.98328-02	.00000	.47896-02	.13531+06	-.11151+06	.43004+05	-.31044+05	.00000	.00000
.0333	.19305-02	.98375-02	.00000	.46641-02	.13514+06	-.11134+06	.42676+05	-.31269+05	.00000	.00000
.0367	.19151-02	.98422-02	.00000	.45387-02	.13498+06	-.11117+06	.42357+05	-.31488+05	.00000	.00000
.0400	.19002-02	.98469-02	.00000	.44136-02	.13481+06	-.11101+06	.42047+05	-.31701+05	.00000	.00000

.0400	.19002-02	.98469-02	.00000	.44136-02	.13481+06	-.11101+06	.42047+05	-.31701+05	.00000	.00000
.0433	.18857-02	.98516-02	.00000	.42885-02	.13465+06	-.11085+06	.41745+05	-.31907+05	.00000	.00000
.0467	.18716-02	.98563-02	.00000	.41637-02	.13450+06	-.11070+06	.41451+05	-.32107+05	.00000	.00000
.0500	.18580-02	.98610-02	.00000	.40390-02	.13435+06	-.11054+06	.41165+05	-.32301+05	.00000	.00000

MAIN SHELL PART NO 7

.0000	.98610-02	-.18580-02	.00000	.40390-02	.77162+05	-.79567+05	.32861+05	-.31858+05	.00000	.00000
.0184	.97896-02	-.18392-02	.00000	.37069-02	.73443+05	-.75885+05	.31131+05	-.30091+05	.00000	.00000
.0369	.97242-02	-.18204-02	.00000	.33905-02	.69753+05	-.72234+05	.29431+05	-.28353+05	.00000	.00000
.0553	.96645-02	-.18017-02	.00000	.30896-02	.66092+05	-.68613+05	.27763+05	-.26644+05	.00000	.00000

.0553	.96645-02	-.18017-02	.00000	.30896-02	.66092+05	-.68613+05	.27763+05	-.26644+05	.00000	.00000
.0738	.96101-02	-.17829-02	.00000	.28043-02	.62460+05	-.65022+05	.26126+05	-.24965+05	.00000	.00000
.0922	.95609-02	-.17642-02	.00000	.25343-02	.58855+05	-.61461+05	.24521+05	-.23317+05	.00000	.00000
.1107	.95165-02	-.17455-02	.00000	.22795-02	.55279+05	-.57928+05	.22948+05	-.21700+05	.00000	.00000

.1107	.95165-02	-.17455-02	.00000	.22795-02	.55279+05	-.57928+05	.22948+05	-.21700+05	.00000	.00000
.1291	.94767-02	-.17268-02	.00000	.20400-02	.51729+05	-.54425+05	.21407+05	-.20114+05	.00000	.00000
.1476	.94412-02	-.17082-02	.00000	.18156-02	.48206+05	-.50949+05	.19900+05	-.18559+05	.00000	.00000
.1660	.94097-02	-.16895-02	.00000	.16061-02	.44709+05	-.47502+05	.18427+05	-.17036+05	.00000	.00000

MAIN SHELL PART NO 8

.0000	.94097-02	-.16895-02	.00000	.16061-02	.30854+05	-.33181+05	.15051+05	-.13520+05	.00000	.00000
.0228	.93746-02	-.16664-02	.00000	.14715-02	.27842+05	-.30228+05	.13858+05	-.12269+05	.00000	.00000
.0456	.93425-02	-.16433-02	.00000	.13501-02	.24855+05	-.27302+05	.12703+05	-.11053+05	.00000	.00000
.0683	.93130-02	-.16202-02	.00000	.12420-02	.21891+05	-.24403+05	.11589+05	-.98747+04	.00000	.00000

.0683	.93130-02	-.16202-02	.00000	.12420-02	.21891+05	-.24403+05	.11589+05	-.98747+04	.00000	.00000
.0911	.92858-02	-.15971-02	.00000	.11470-02	.18950+05	-.21529+05	.10516+05	-.87343+04	.00000	.00000
.1139	.92607-02	-.15741-02	.00000	.10652-02	.16030+05	-.18679+05	.94851+04	-.76328+04	.00000	.00000
.1367	.92372-02	-.15511-02	.00000	.99632-03	.13130+05	-.15853+05	.84977+04	-.65714+04	.00000	.00000



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.1367	.92377-02	-.15511-02	.00000	.99632-03	.13130+05	-.15853+05	.84977+04	-.65714+04	.00000	.00000
.1594	.92152-02	-.15281-02	.00000	.94049-03	.10248+05	-.13049+05	.75550+04	-.55510+04	.00000	.00000
.1822	.91943-02	-.15052-02	.00000	.89763-03	.73840+04	-.10267+05	.66866+04	-.45730+04	.00000	.00000
.2050	.91742-02	-.14823-02	.00000	.86771-03	.45355+04	-.75039+04	.58101+04	-.36386+04	.00000	.00000

MAIN SHELL PART NO 9

.0000	.14823-02	.91742-02	.00000	.86771-03	.16162+06	-.97036+05	.50016+05	-.27580+05	.00000	.00000
.0740	.17415-02	.92402-02	.00000	-.72443-02	.11322+06	-.48637+05	.41309+05	-.72479+04	.00000	.00000
.1479	.24812-02	.93779-02	.00000	-.12421-01	.86871+05	-.19239+05	.48697+05	.16864+05	.00000	.00000
.2219	.35471-02	.94232-02	.00000	-.16186-01	.71374+05	.84258+04	.63706+05	.44822+05	.00000	.00000

.2219	.35464-02	.94233-02	.00000	-.16179-01	.71364+05	.84364+04	.63688+05	.44810+05	.00000	.00000
.2958	.48315-02	.95453-02	.00000	-.18157-01	.53123+05	.44184+05	.82661+05	.79979+05	.00000	.00000
.3698	.61298-02	.97730-02	.00000	-.15778-01	.18721+05	.10593+06	.96951+05	.12311+06	.00000	.00000
.4437	.70415-02	.10122-01	.00000	-.91157-02	.27416+05	.99755+05	.11547+06	.13717+06	.00000	.00000

.4437	.70312-02	.10125-01	.00000	-.90296-02	.27567+05	.99604+05	.11529+06	.13690+06	.00000	.00000
.5177	.75211-02	.10422-01	.00000	-.46178-02	.42962+05	.84209+05	.12641+06	.13878+06	.00000	.00000
.5917	.77681-02	.10675-01	.00000	-.23678-02	.54759+05	.72412+05	.13105+06	.13634+06	.00000	.00000
.6656	.79077-02	.10901-01	.00000	-.15921-02	.61810+05	.65361+05	.13190+06	.13796+06	.00000	.00000

.6656	.79092-02	.10901-01	.00000	-.15952-02	.61752+05	.65419+05	.13191+06	.13301+06	.00000	.00000
.7396	.80242-02	.11121-01	.00000	-.15981-02	.64938+05	.62233+05	.13107+06	.13026+06	.00000	.00000
.8135	.81527-02	.11345-01	.00000	-.18990-02	.65757+05	.61014+05	.12982+06	.12851+06	.00000	.00000
.8875	.83056-02	.11579-01	.00000	-.22283-02	.65460+05	.61711+05	.12877+06	.12765+06	.00000	.00000

.8875	.83075-02	.11579-01	.00000	-.22384-02	.65446+05	.61725+05	.12881+06	.12769+06	.00000	.00000
.9615	.84828-02	.11826-01	.00000	-.24837-02	.64797+05	.62375+05	.12814+06	.12742+06	.00000	.00000
1.0354	.86724-02	.12087-01	.00000	-.26285-02	.64220+05	.62951+05	.12782+06	.12743+06	.00000	.00000
1.1094	.88697-02	.12360-01	.00000	-.26980-02	.63859+05	.63312+05	.12772+06	.12755+06	.00000	.00000

1.1094	.88709-02	.12360-01	.00000	-.26971-02	.63791+05	.63380+05	.12772+06	.12760+06	.00000	.00000
1.1833	.90711-02	.12644-01	.00000	-.27112-02	.63583+05	.63588+05	.12773+06	.12773+06	.00000	.00000
1.2573	.92714-02	.12940-01	.00000	-.27035-02	.63510+05	.63661+05	.12778+06	.12783+06	.00000	.00000
1.3312	.94709-02	.13245-01	.00000	-.26910-02	.63513+05	.63658+05	.12784+06	.12788+06	.00000	.00000

1.3312	.94705-02	.13246-01	.00000	-.26832-02	.63474+05	.63697+05	.12781+06	.12788+06	.00000	.00000
1.4052	.96683-02	.13562-01	.00000	-.26672-02	.63504+05	.63668+05	.12784+06	.12789+06	.00000	.00000
1.4792	.98651-02	.13888-01	.00000	-.26581-02	.63560+05	.63611+05	.12785+06	.12786+06	.00000	.00000
1.5531	.10062-01	.14225-01	.00000	-.26607-02	.63649+05	.63522+05	.12786+06	.12782+06	.00000	.00000

1.5531	.10062-01	.14225-01	.00000	-.26572-02	.63601+05	.63570+05	.12785+06	.12785+06	.00000	.00000
1.6271	.10259-01	.14572-01	.00000	-.26675-02	.63704+05	.63468+05	.12787+06	.12780+06	.00000	.00000
1.7010	.10457-01	.14928-01	.00000	-.26983-02	.63851+05	.63321+05	.12794+06	.12778+06	.00000	.00000
1.7750	.10659-01	.15295-01	.00000	-.27559-02	.64024+05	.63147+05	.12807+06	.12781+06	.00000	.00000

1.7750	.10659-01	.15295-01	.00000	-.27497-02	.63969+05	.63202+05	.12806+06	.12783+06	.00000	.00000
1.8490	.10865-01	.15671-01	.00000	-.28224-02	.64069+05	.63102+05	.12827+06	.12798+06	.00000	.00000
1.9229	.11076-01	.16058-01	.00000	-.28983-02	.63988+05	.63187+05	.12825+06	.12801+06	.00000	.00000
1.9969	.11293-01	.16457-01	.00000	-.29427-02	.63698+05	.63474+05	.12809+06	.12802+06	.00000	.00000

1.9969	.11293-01	.16457-01	.00000	-.29355-02	.63638+05	.63533+05	.12807+06	.12804+06	.00000	.00000
2.0708	.11509-01	.16870-01	.00000	-.29083-02	.63188+05	.63983+05	.12785+06	.12802+06	.00000	.00000
2.1448	.11721-01	.17295-01	.00000	-.28056-02	.62848+05	.64161+05	.12753+06	.12792+06	.00000	.00000
2.2187	.11925-01	.17732-01	.00000	-.27304-02	.62945+05	.63461+05	.12716+06	.12732+06	.00000	.00000

2.2187	.11925-01	.17732-01	.00000	-.27231-02	.62879+05	.63527+05	.12714+06	.12734+06	.00000	.00000
2.2927	.12125-01	.18179-01	.00000	-.26935-02	.62853+05	.62956+05	.12663+06	.12666+06	.00000	.00000



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2.3667	.12325-01	.18636-01	.00000	-.27003-02	.62727+05	.62490+05	.12605+06	.12598+06	.00000	.00000
2.4406	.12525-01	.19104-01	.00000	-.27287-02	.62531+05	.62100+05	.12545+06	.12532+06	.00000	.00000
2.4406	.12525-01	.19105-01	.00000	-.27198-02	.62462+05	.62169+05	.12543+06	.12534+06	.00000	.00000
2.5146	.12728-01	.19585-01	.00000	-.27467-02	.62198+05	.61852+05	.12482+06	.12472+06	.00000	.00000
2.5885	.12932-01	.20076-01	.00000	-.27767-02	.61921+05	.61554+05	.12423+06	.12412+06	.00000	.00000
2.6625	.13138-01	.20579-01	.00000	-.28073-02	.61645+05	.61260+05	.12367+06	.12355+06	.00000	.00000
2.6625	.13138-01	.20580-01	.00000	-.27972-02	.61577+05	.61329+05	.12364+06	.12357+06	.00000	.00000
2.7365	.13346-01	.21095-01	.00000	-.28160-02	.61274+05	.61066+05	.12307+06	.12301+06	.00000	.00000
2.8104	.13554-01	.21622-01	.00000	-.28310-02	.60973+05	.60808+05	.12250+06	.12245+06	.00000	.00000
2.8844	.13764-01	.22161-01	.00000	-.28432-02	.60674+05	.60552+05	.12193+06	.12189+06	.00000	.00000
2.8844	.13764-01	.22162-01	.00000	-.28347-02	.60611+05	.60615+05	.12191+06	.12191+06	.00000	.00000
2.9583	.13974-01	.22713-01	.00000	-.28308-02	.60295+05	.60382+05	.12131+06	.12133+06	.00000	.00000
3.0323	.14183-01	.23277-01	.00000	-.28225-02	.60019+05	.60114+05	.12068+06	.12071+06	.00000	.00000
3.1062	.14391-01	.23853-01	.00000	-.28204-02	.59840+05	.59753+05	.12006+06	.12003+06	.00000	.00000
3.1062	.14392-01	.23853-01	.00000	-.28283-02	.59855+05	.59738+05	.12008+06	.12005+06	.00000	.00000
3.1802	.14602-01	.24440-01	.00000	-.28561-02	.59843+05	.59215+05	.11952+06	.11933+06	.00000	.00000
3.2542	.14816-01	.25038-01	.00000	-.29441-02	.60070+05	.58458+05	.11908+06	.11860+06	.00000	.00000
3.3281	.15040-01	.25646-01	.00000	-.31340-02	.60563+05	.57440+05	.11890+06	.11796+06	.00000	.00000
3.3281	.15040-01	.25647-01	.00000	-.31242-02	.60496+05	.57507+05	.11888+06	.11798+06	.00000	.00000
3.4021	.15282-01	.26264-01	.00000	-.34400-02	.61119+05	.56363+05	.11906+06	.11764+06	.00000	.00000
3.4760	.15552-01	.26890-01	.00000	-.38902-02	.61538+05	.55428+05	.11972+06	.11789+06	.00000	.00000
3.5500	.15859-01	.27527-01	.00000	-.43854-02	.60995+05	.55459+05	.12077+06	.11911+06	.00000	.00000
3.5500	.15859-01	.27527-01	.00000	-.43851-02	.60973+05	.55482+05	.12077+06	.11912+06	.00000	.00000
3.6240	.16196-01	.28179-01	.00000	-.46689-02	.58216+05	.57732+05	.12172+06	.12157+06	.00000	.00000
3.6979	.16533-01	.28858-01	.00000	-.42578-02	.51670+05	.63775+05	.12133+06	.12496+06	.00000	.00000
3.7719	.16791-01	.29581-01	.00000	-.24126-02	.39964+05	.74983+05	.11785+06	.12836+06	.00000	.00000
3.7719	.16791-01	.29581-01	.00000	-.24030-02	.39902+05	.75045+05	.11783+06	.12837+06	.00000	.00000
3.8458	.16831-01	.30371-01	.00000	.17669-02	.22944+05	.91508+05	.10858+06	.12915+06	.00000	.00000
3.9198	.16886-01	.31190-01	.00000	.68238-02	.31329+05	.65569+05	.99622+05	.10989+06	.00000	.00000
3.9937	.15934-01	.31909-01	.00000	.77147-02	.38850+05	.38613+05	.86571+05	.86500+05	.00000	.00000
3.9937	.15983-01	.31898-01	.00000	.73392-02	.38426+05	.39037+05	.87374+05	.87557+05	.00000	.00000
4.0677	.15447-01	.32602-01	.00000	.70976-02	.36259+05	.28264+05	.71836+05	.69437+05	.00000	.00000
4.1417	.14936-01	.33318-01	.00000	.67463-02	.30331+05	.26798+05	.55767+05	.54707+05	.00000	.00000
4.2156	.14431-01	.34061-01	.00000	.70455-02	.20210+05	.36919+05	.38681+05	.43694+05	.00000	.00000
4.2156	.14430-01	.34062-01	.00000	.70617-02	.20251+05	.36878+05	.38664+05	.43652+05	.00000	.00000
4.2896	.13875-01	.34835-01	.00000	.79830-02	.16382+05	.40747+05	.22657+05	.29966+05	.00000	.00000
4.3635	.13252-01	.35635-01	.00000	.87758-02	.24383+05	.32746+05	.90584+04	.11567+05	.00000	.00000
4.4375	.12611-01	.36455-01	.00000	.81800-02	.50304+05	.68255+04	.67373+03	.12370+05	.00000	.00000

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1.5708	.12611-01	.36454-01	.00000	.81814-02	.50288+05	.68413+04	.66763+03	.12366+05	.00000	.00000
1.6134	.14048-01	.36635-01	.00000	.78042-02	.56647+05	.93325+03	.85854+03	.16252+05	.00000	.00000
1.6559	.15471-01	.35555-01	.00000	.73376-02	.62345+05	.43297+04	.90144+03	.19846+05	.00000	.00000
1.6559	.15471-01	.35555-01	.00000	.73376-02	.62345+05	.43298+04	.90153+03	.19846+05	.00000	.00000
1.6985	.16878-01	.35016-01	.00000	.67884-02	.67419+05	.89799+04	.81503+03	.23138+05	.00000	.00000
1.7410	.18268-01	.34419-01	.00000	.61617-02	.71902+05	.13044+05	.61633+03	.26117+05	.00000	.00000
1.7410	.18268-01	.34419-01	.00000	.61616-02	.71902+05	.13044+05	.61636+03	.26117+05	.00000	.00000
1.7836	.19638-01	.33766-01	.00000	.54616-02	.75820+05	.16541+05	.32192+03	.28770+05	.00000	.00000

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1.8262	.20989-01	.33058-01	.00000	.46915-02	.79195+05	-.19489+05	-.52043+02	-.31083+05	.00000	.00000
1.8262	.20989-01	.33058-01	.00000	.46914-02	.79195+05	-.19489+05	-.52031+02	-.31083+05	.00000	.00000
1.8687	.22318-01	.32294-01	.00000	.38536-02	.82046+05	-.21899+05	-.48892+03	-.31037+05	.00000	.00000
1.9113	.23625-01	.31486-01	.00000	.29499-02	.84387+05	-.23777+05	-.97127+03	-.34613+05	.00000	.00000
1.9113	.23625-01	.31486-01	.00000	.29499-02	.84387+05	-.23777+05	-.97129+03	-.34613+05	.00000	.00000
1.9538	.24909-01	.30625-01	.00000	.19819-02	.86232+05	-.25128+05	-.14802+04	-.35789+05	.00000	.00000
1.9964	.26169-01	.29716-01	.00000	.95064-03	.87588+05	-.25950+05	-.19946+04	-.36535+05	.00000	.00000
1.9964	.26169-01	.29716-01	.00000	.95060-03	.87587+05	-.25950+05	-.19946+04	-.36535+05	.00000	.00000
2.0390	.27407-01	.28762-01	.00000	-.14272-03	.88461+05	-.26241+05	-.24908+04	-.36822+05	.00000	.00000
2.0815	.28623-01	.27765-01	.00000	-.12969-02	.88856+05	-.25993+05	-.29417+04	-.36613+05	.00000	.00000
2.0815	.28623-01	.27765-01	.00000	-.12970-02	.88856+05	-.25993+05	-.29418+04	-.36613+05	.00000	.00000
2.1241	.29818-01	.26728-01	.00000	-.25105-02	.88775+05	-.25199+05	-.33160+04	-.35865+05	.00000	.00000
2.1666	.30994-01	.25652-01	.00000	-.37811-02	.88215+05	-.23445+05	-.35772+04	-.34530+05	.00000	.00000
2.1666	.30994-01	.25652-01	.00000	-.37811-02	.88215+05	-.23445+05	-.35773+04	-.34530+05	.00000	.00000
2.2092	.32154-01	.24540-01	.00000	-.51055-02	.87174+05	-.21917+05	-.36833+04	-.32553+05	.00000	.00000
2.2518	.33302-01	.23394-01	.00000	-.64787-02	.85643+05	-.19398+05	-.35853+04	-.29870+05	.00000	.00000
2.2518	.33302-01	.23394-01	.00000	-.64788-02	.85643+05	-.19397+05	-.35855+04	-.29870+05	.00000	.00000
2.2943	.34442-01	.22718-01	.00000	-.78937-02	.83607+05	-.16263+05	-.32275+04	-.26407+05	.00000	.00000
2.3369	.35581-01	.21014-01	.00000	-.93399-02	.81043+05	-.12486+05	-.25457+04	-.22080+05	.00000	.00000
2.3369	.35581-01	.21014-01	.00000	-.93401-02	.81043+05	-.12485+05	-.25462+04	-.22080+05	.00000	.00000
2.3794	.36726-01	.19785-01	.00000	-.10802-01	.77910+05	-.80254+04	-.14698+04	-.16796+05	.00000	.00000
2.4220	.37885-01	.18534-01	.00000	-.12259-01	.74141+05	-.28274+04	.77715+02	-.10445+05	.00000	.00000
2.4220	.37885-01	.18534-01	.00000	-.12259-01	.74140+05	-.28262+04	.76867+02	-.10445+05	.00000	.00000
2.4686	.39068-01	.17263-01	.00000	-.13678-01	.69625+05	.31934+04	.21749+04	-.29046+04	.00000	.00000
2.5071	.40284-01	.15975-01	.00000	-.15012-01	.64184+05	.10166+05	.48882+04	.59597+04	.00000	.00000
2.5071	.40284-01	.15975-01	.00000	-.15013-01	.64183+05	.10168+05	.48862+04	.59592+04	.00000	.00000
2.5497	.41544-01	.14674-01	.00000	-.16192-01	.57527+05	.18298+05	.83049+04	.16292+05	.00000	.00000
2.5922	.42855-01	.13362-01	.00000	-.17109-01	.49187+05	.27918+05	.12423+05	.28237+05	.00000	.00000
2.5922	.42855-01	.13362-01	.00000	-.17110-01	.49187+05	.27921+05	.12418+05	.28235+05	.00000	.00000
2.6348	.44217-01	.12043-01	.00000	-.17598-01	.38428+05	.39553+05	.17209+05	.41902+05	.00000	.00000
2.6774	.45618-01	.10720-01	.00000	-.17394-01	.24092+05	.54030+05	.22518+05	.57308+05	.00000	.00000
2.6774	.45618-01	.10721-01	.00000	-.17396-01	.24094+05	.54037+05	.22505+05	.57300+05	.00000	.00000
2.7199	.47018-01	.93993-02	.00000	-.16074-01	.44272+04	.72641+05	.28008+05	.74215+05	.00000	.00000
2.7625	.48327-01	.80880-02	.00000	-.12948-01	-.23227+05	.97361+05	.33108+05	.91867+05	.00000	.00000
2.7625	.48326-01	.80888-02	.00000	-.12953-01	-.23214+05	.97376+05	.33073+05	.91841+05	.00000	.00000
2.8050	.49361-01	.68030-02	.00000	-.69031-02	-.62637+05	.13114+06	.36834+05	.10824+06	.00000	.00000
2.8476	.49773-01	.55718-02	.00000	-.38774-02	-.11915+06	.17836+06	.37928+05	.11883+06	.00000	.00000
FICTITIOUS VALUE - BASED ON FICTITIOUS ϵ , μ , σ										
HAYN SHELL PART NO 11	.0000	.24717-01	.43555-01	.00000	.38690-02	-.13125+05	.34273+05	.67256+05	.75335+05	.00000
.0529	.24497-01	.44061-01	.00000	.43845-02	.83707+03	.19654+05	.66256+05	.65497+05	.00000	.00000
.0529	.24497-01	.44061-01	.00000	.43844-02	.83709+03	.19654+05	.66256+05	.65497+05	.00000	.00000
.1058	.24260-01	.44575-01	.00000	.45163-02	.13074+05	.71936+04	.63499+05	.55740+05	.00000	.00000
.1058	.24260-01	.44575-01	.00000	.45162-02	.13074+05	.71935+04	.63499+05	.55740+05	.00000	.00000
.1588	.24026-01	.45095-01	.00000	.42408-02	.22992+05	-.23311+04	.59519+05	.46888+05	.00000	.00000



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.1588	.24026-01	.45095-01	.00000	.42407-02	.22992+05	-.23313+04	.59519+05	.46887+05	.00000	.00000
.2117	.23818-01	.45622-01	.00000	.35640-02	.29523+05	-.75999+04	.54933+05	.39992+05	.00000	.00000
.2117	.23818-01	.45622-01	.00000	.35640-02	.29523+05	-.76001+04	.54833+05	.39991+05	.00000	.00000
.2646	.23654-01	.46154-01	.00000	.25939-02	.30192+05	-.57233+04	.49583+05	.36517+05	.00000	.00000
.2646	.23654-01	.46154-01	.00000	.25939-02	.30192+05	-.57236+04	.49582+05	.36517+05	.00000	.00000
.3175	.23541-01	.46689-01	.00000	.18222-02	.18084+05	.11047+05	.42261+05	.38842+05	.00000	.00000

MAIN SHELL PART NO 12

.0000	.69493-02	.51924-01	.00000	.18223-02	.20043+05	.12154+05	.42194+05	.39827+05	.00000	.00000
.0739	.68354-02	.52583-01	.00000	.12191-02	.22355+05	.98419+04	.38265+05	.34511+05	.00000	.00000
.1478	.67691-02	.53345-01	.00000	.59995-03	.20990+05	.11207+05	.35165+05	.32231+05	.00000	.00000
.2217	.67415-02	.54108-01	.00000	.18741-03	.18860+05	.13337+05	.33403+05	.31747+05	.00000	.00000
.2217	.67415-02	.54108-01	.00000	.18718-03	.18860+05	.13337+05	.33404+05	.31747+05	.00000	.00000
.2956	.67363-02	.54872-01	.00000	-.16112-04	.17224+05	.14973+05	.32701+05	.32025+05	.00000	.00000
.3694	.67406-02	.55637-01	.00000	-.84388-04	.16358+05	.15839+05	.32615+05	.32459+05	.00000	.00000
.4433	.67473-02	.56400-01	.00000	-.94247-04	.16100+05	.16097+05	.32812+05	.32812+05	.00000	.00000
.4433	.67461-02	.56400-01	.00000	-.75104-04	.15974+05	.16223+05	.32724+05	.32799+05	.00000	.00000
.5172	.67512-02	.57164-01	.00000	-.63684-04	.16056+05	.16141+05	.32955+05	.32980+05	.00000	.00000
.5911	.67560-02	.57928-01	.00000	-.71501-04	.16295+05	.15902+05	.33223+05	.33105+05	.00000	.00000
.6650	.67624-02	.58691-01	.00000	-.10413-03	.16476+05	.15721+05	.33535+05	.33309+05	.00000	.00000
.6650	.67631-02	.58691-01	.00000	-.11596-03	.16560+05	.15637+05	.33590+05	.33313+05	.00000	.00000
.7389	.67734-02	.59054-01	.00000	-.16209-03	.16396+05	.15801+05	.33962+05	.33784+05	.00000	.00000
.8128	.67857-02	.60216-01	.00000	-.15087-03	.15413+05	.16784+05	.34163+05	.34574+05	.00000	.00000
.8867	.67915-02	.60979-01	.00000	.33870-04	.13110+05	.19087+05	.33710+05	.35503+05	.00000	.00000
.8867	.67921-02	.60979-01	.00000	.24158-04	.13180+05	.19017+05	.33754+05	.35506+05	.00000	.00000
.9606	.67741-02	.61741-01	.00000	.53315-03	.93665+04	.22830+05	.31878+05	.35917+05	.00000	.00000
1.0344	.67017-02	.62505-01	.00000	.15053-02	.49105+04	.27286+05	.27605+05	.34318+05	.00000	.00000
1.1083	.65417-02	.63273-01	.00000	.28618-02	.30761+04	.29121+05	.20556+05	.28370+05	.00000	.00000
1.1083	.65424-02	.63273-01	.00000	.28505-02	.31540+04	.29043+05	.20608+05	.28375+05	.00000	.00000
1.1822	.62857-02	.64049-01	.00000	.39594-02	.10928+05	.21269+05	.12520+05	.15622+05	.00000	.00000
1.2561	.60013-02	.64835-01	.00000	.32320-02	.39190+05	.69927+04	.94516+04	.44031+04	.00000	.00000
1.3300	.59229-02	.65629-01	.00000	-.21950-02	.99455+05	.67258+05	.24348+05	.25667+05	.00000	.00000

MAIN SHELL PART NO 13

.0000	.62838-01	.19841-01	.00000	-.22033-02	.29109+05	-.14280+05	-.85633+03	-.56198+04	.00000	.00000
.0484	.62959-01	.20345-01	.00000	-.27238-02	.13760+05	.12315+04	-.64461+04	.19201+04	.00000	.00000
.0484	.62959-01	.20345-01	.00000	-.27239-02	.13760+05	.12314+04	-.64461+04	.19203+04	.00000	.00000
.0968	.63095-01	.20849-01	.00000	-.28394-02	.49483+04	.10255+05	-.91207+04	.74635+04	.00000	.00000
.0968	.63095-01	.20849-01	.00000	-.28394-02	.49482+04	.10255+05	-.91206+04	.74635+04	.00000	.00000
.1452	.63231-01	.21352-01	.00000	-.27652-02	.38893+03	.14982+05	-.99430+04	.11765+05	.00000	.00000
.1452	.63231-01	.21352-01	.00000	-.27651-02	.38875+03	.14982+05	-.99429+04	.11764+05	.00000	.00000
.1936	.63362-01	.21854-01	.00000	-.26225-02	-.13693+04	.16764+05	-.95858+04	.15425+05	.00000	.00000
.1936	.63362-01	.21854-01	.00000	-.26224-02	-.13696+04	.16764+05	-.95857+04	.15425+05	.00000	.00000
.2420	.63485-01	.22355-01	.00000	-.24811-02	-.12926+04	.16429+05	-.84834+04	.19018+05	.00000	.00000
.2420	.63485-01	.22355-01	.00000	-.24809-02	-.12931+04	.16430+05	-.84832+04	.19017+05	.00000	.00000



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OF CALIFORNIA

.2905	.63602-01	.22854-01	.00000	-.23822-02	-.76641+02	.14439+05	-.69150+04	.23208+05	.00000	.00000
MAIN SHELL PART NO 14										
.0000	.67496-01	-.34384-02	.00000	-.23821-02	-.58745+03	.13930+05	-.81471+04	.24135+05	.00000	.00000
.0233	.67551-01	-.31995-02	.00000	-.23458-02	-.22850+04	.15421+05	-.93443+04	.25538+05	.00000	.00000
.0466	.67605-01	-.29608-02	.00000	-.22965-02	-.37770+04	.16654+05	-.10490+05	.26943+05	.00000	.00000
.0466	.67605-01	-.29608-02	.00000	-.22965-02	-.37770+04	.16654+05	-.10490+05	.26943+05	.00000	.00000
.0699	.67658-01	-.27222-02	.00000	-.22370-02	-.50442+04	.17591+05	-.11600+05	.28384+05	.00000	.00000
.0932	.67710-01	-.24839-02	.00000	-.21708-02	-.60584+04	.18173+05	-.12697+05	.29913+05	.00000	.00000
.0932	.67710-01	-.24839-02	.00000	-.21708-02	-.60584+04	.18173+05	-.12697+05	.29913+05	.00000	.00000
.1165	.67759-01	-.22459-02	.00000	-.21019-02	-.67760+04	.18312+05	-.13818+05	.31612+05	.00000	.00000
.1398	.67808-01	-.20083-02	.00000	-.20361-02	-.71265+04	.17863+05	-.15023+05	.33617+05	.00000	.00000
.1398	.67808-01	-.20083-02	.00000	-.20361-02	-.71265+04	.17863+05	-.15023+05	.33617+05	.00000	.00000
.1631	.67854-01	-.17713-02	.00000	-.19809-02	-.69894+04	.16574+05	-.16420+05	.36167+05	.00000	.00000
.1864	.67900-01	-.15352-02	.00000	-.19479-02	-.61450+04	.13986+05	-.18211+05	.39701+05	.00000	.00000
.1864	.67900-01	-.15352-02	.00000	-.19479-02	-.61445+04	.13986+05	-.18211+05	.39701+05	.00000	.00000
.2097	.67945-01	-.13005-02	.00000	-.19562-02	-.41503+04	.91689+04	-.20810+05	.45123+05	.00000	.00000
.2330	.67992-01	-.10681-02	.00000	-.20410-02	-.26445+01	.18633+01	-.25175+05	.54507+05	.00000	.00000

IBRM= 0 WHICH INDICATES END OF JOB. EXIT CALLED

DATE 18 JAN 74
 PART NO. 852579
 PREPARED BY MORIMOTO

CALC. NO. C6263 SHEET NO. 7-59
 MODEL NO. 1/4 W, V.M.
 CHECKED BY _____

7.2.4 SHELL AND DISPLACER DEFLECTIONS

THE DEFLECTION OF THE SHELL AND DISPLACER WILL BE CHECKED AGAINST THE CLEARANCES.

SHELL DEFLECTION DUE TO DISTRIBUTED LOAD, w AND END LOAD W .

$$\delta = \frac{wL^4}{8EI} + \delta'$$

$$\begin{aligned}\delta' &= 6.77 \times 10^{-6} \text{ IN.} \\ w &= 0.114 \text{ LB/IN.} \\ I &= .349 \text{ IN}^4 \\ L &= 4.0\end{aligned}$$

} REF. PG. 7-10

$$= \frac{.114 \times 4^4}{8 \times 29.8 \times 10^6 \times .349} + 6.77 \times 10^{-6}$$

$$= 7.14 \times 10^{-6} \text{ IN. PER 1 G.}$$

$$= 0.00062 \text{ IN. PER 86.6 G's}$$

DISPLACER DEFLECTION

$$\delta_D = \frac{WL^3}{48EI}$$

$$W = .94 \text{ LBS.}$$

$$I = \frac{\pi}{64} (2.222^4 - 2.142^4) = 0.163 \text{ IN}^4$$

$$= \frac{.94 \times 5^3}{48 \times 29.8 \times 10^6 \times .163}$$

$$L = 5.0 \text{ IN.}$$

$$= 0.503 \times 10^{-6} \text{ IN. PER 1 G.}$$

$$= 0.000043 \text{ IN. PER 86.6 G's}$$

SINCE THE MIN. RADIAL CLEARANCE, IS 0.025 IN, THE RELATIVE MOTION OF THE SHELL AND DISPLACER IS MUCH LESS THAN THE CLEARANCE.



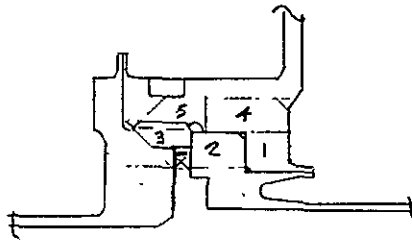
DATE 8 Oct '73
 PART NO. 852579
 PREPARED BY M. CALDERON

CALC. NO. 6263 SHEET NO. 7-60
 MODEL NO. 1/4 WATT V/M
 CHECKED BY _____

7.3 FLANGE ASSY

7.3.1 NUT PRELOAD

PART	L	O.D.	I.D.	A	E	S *
1	.25	3.5	3.05	2.315	29×10^6	3.723×10^{-9}
2	.30	3.5	3.0	2.553	29×10^6	4.053×10^{-9}
3	.30	3.5	3.25	1.325	29×10^6	7.805×10^{-9}
					$\Sigma S_c =$	1.558×10^{-8}
4	.50	3.9	3.5	2.325	29×10^6	7.416×10^{-9}
5	.35	3.9	3.6	1.767	29×10^6	6.830×10^{-9}



$$\Sigma S_t = 1.4246 \times 10^{-8}$$

$$*S = \frac{L}{AE} \quad (in/lb)$$

COMPRESSIVE STACK-UP $\Sigma S_c = 1.558 \times 10^{-8} \text{ in/lb}$

TENSILE STACK-UP $\Sigma S_t = 1.4246 \times 10^{-8} \text{ in/lb}$

CHANGE IN PRELOAD DUE TO INTERNAL LOAD:

$$\Delta P_{NUT} = \frac{\Sigma S_{RELAX}}{\Sigma S_n} P_{INT}$$

$$\Delta P_{NUT} = \frac{S_1 + S_2}{\Sigma S_n} P_{INT} = \frac{7.776 \times 10^{-9}}{2.973 \times 10^{-8}} P_{INT}$$

$$\Delta P_{NUT} = +.261 P_{INT}$$



DATE 5 OCT. '73
 PART NO. 852579
 PREPARED BY M. CALDERON

CALC. NO. C 6263 SHEET NO. 7-61
 MODEL NO. 1/4 WATT V/M
 CHECKED BY _____

7.3.1 NUT PRELOAD

LOAD / TORQUE RELATIONSHIP

$$\frac{F_a}{T} = \frac{2}{\frac{D_p}{\left(\frac{1}{\sqrt{R}} - f_t \sin \lambda\right)} \left(\frac{\tan \lambda}{\sqrt{R}} + f_t \cos \lambda\right) + \frac{f_h D_m}{\cos \xi}}$$

F_a - AXIAL LOAD

T - TORQUE

D_p - PITCH DIA

λ - HELIX ANGLE

f_t - THD FRICTION FACTOR

D_m - MEAN CONTACT DIA AT NUT FACE

ξ - FOR FLAT SURFACE $\cos \xi \approx 1.0$

ϕ - THD. PRESSURE ANGLE

$R = 1 + \tan^2 \lambda + \tan^2 \phi$

f_h - NUT FACE FRICTION FACTOR

FOR A 20 THD/IN PITCH AND 7° PRESSURE ANGLE WITH

$$f_t = f_h = .12, \quad \lambda = 2.8648^\circ (.05 \text{ RAD})$$

$$R = 1.01758, \quad \sqrt{R} = 1.00875$$

$$\frac{F_a}{T} = \frac{2}{\frac{D_p}{(-.991324 - .005777)} (-.16346) + .12 D_m}$$

$$\frac{F_a}{T} = \frac{1}{.00577 D_p + .06 D_m}$$



DATE 8 OCT '73
PART NO. 852579
PREPARED BY M. CALDERON

CALC. NO. 6263 SHEET NO. 7-62
MODEL NO. 1/4 WATT V/M
CHECKED BY _____

7.3.1 NUT PRELOAD

$$F_a = \frac{T}{.08599 D_p + .06 D_m}$$

$$D_p = 3.580 \text{ IN}, \quad D_m = 3.150 \text{ IN}$$

$$F_a = 2.013 T \quad \text{FOR } \lambda = .12$$

HOT END DISPLACER FLANGE LOADS

$$\text{MAX OPERATING PRESSURE} = 1250 \text{ PSI}$$

$$\text{PROOF PRESSURE}, 1.68 \times 1250 = 2080 \text{ PSI}$$

$$\text{BURST PRESSURE}, 2.25 \times 1250 = 2800 \text{ PSI}$$

CONSIDER THE SEAL O.D. AS THE EXTENT OF THE PRESSURIZED AREA.

$$F = PA = 1250 \times \frac{\pi}{4} \times 3.25^2$$

$$F = 10,370 \text{ *}$$

$$F_{\text{PROOF}} = 17,300 \text{ *}$$

$$F_{\text{BURST}} = 23,200 \text{ *}$$



DATE 8 OCT '73
PART NO. 852579
PREPARED BY M. CALDERON

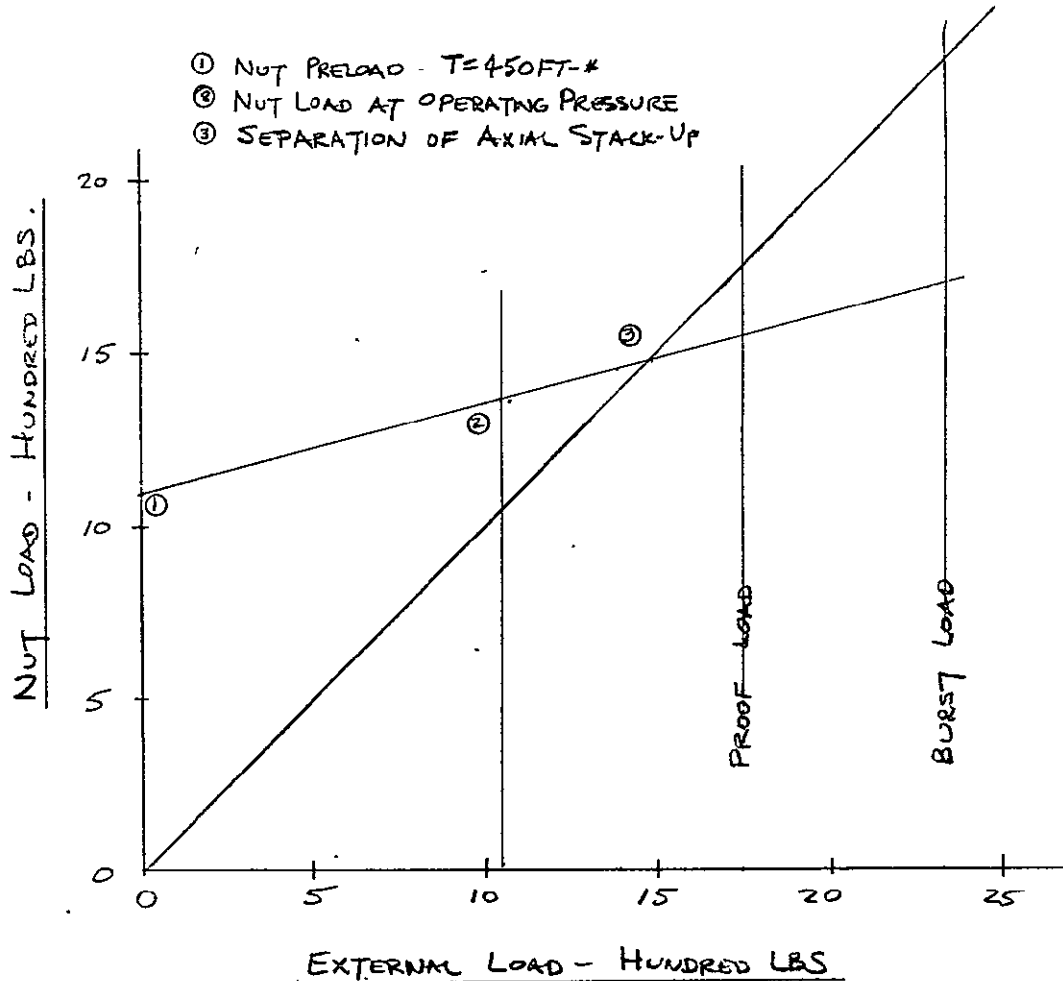
CALC. NO. C6263 SHEET NO. 7-63
MODEL NO. 1/4 WATT V/M
CHECKED BY _____

7.3.1 NUT PRELOAD
FOR $T = 450$ FT-#

$$F_a = 2.013 \times 12 \times 450.$$

$$F_a = 10,900 \text{ ,# } \textcircled{1}$$

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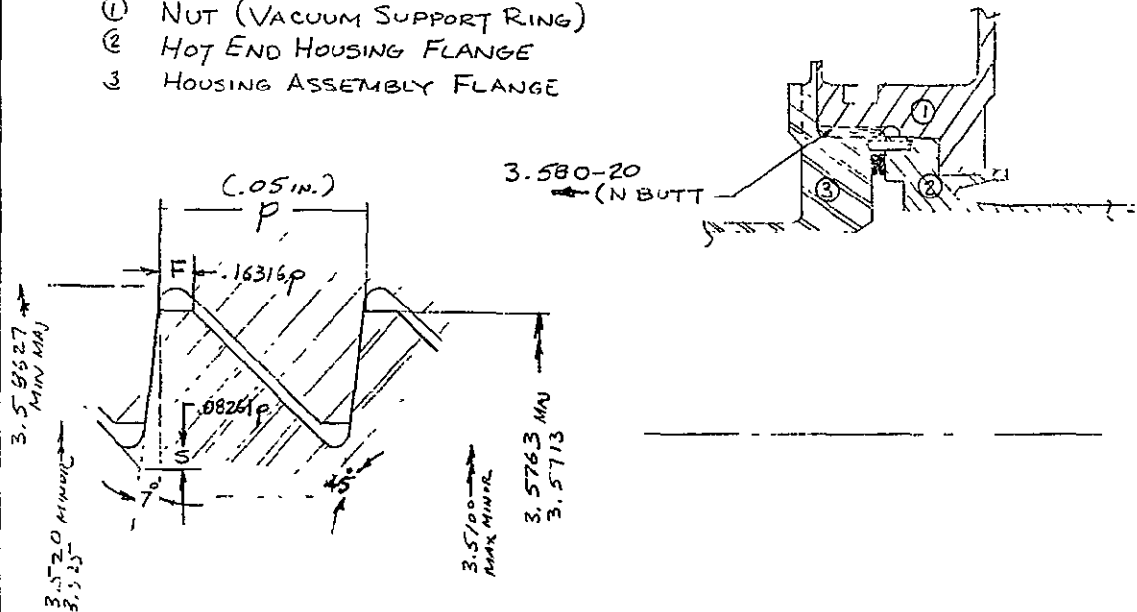
NOTE: ③ AXIAL STACK-UP WILL SEPARATE BUT DEFLECTION WILL NOT EXCEED COMPRESSION OF O-RING OR K-SEAL.

FIG. 7-4 FLANGE NUT LOAD VS. EXTERNAL LOAD



CALC. NO. 6263 SHEET NO. 7-64
MODEL NO. 1/4 WATT V/M,
CHECKED BY _____

- ① NUT (VACUUM SUPPORT RING)
- ② HOT END HOUSING FLANGE
- ③ HOUSING ASSEMBLY FLANGE


$$S_{RAD} = \frac{3.570}{2} + .0826/x.05 = 1.759 \text{ IN}$$

$$w_1 = \left(\frac{3.5713}{2} - 1.759 \right) \tan 7^\circ = .00327 \text{ N}$$

$$w_2 = \left(\frac{3.5713}{2} - 1.759 \right) \tan 45^\circ = 0.02665 \text{ N}$$

$$F = .16316 p = .16316 \times .05 = .00816 \text{ N}$$

THICKNESS AT 5 RADIUS = .03808 IN

THICKNESS AT $R = \frac{3.525}{2} = 1.7625 \text{ IN}$

$$t = .00327 \times \frac{1.759}{1.7625} + .02665 \times \frac{1.759}{1.7625} + .00816$$

$$t_{s_{11.71}} = .03802 \text{ IN}$$

DATE 8 OCT. '73
PART NO. 852577
PREPARED BY M. CALDERON

CALC. NO. C6263 SHEET NO. 7-65
MODEL NO. 1/4 WATT V/M P/N 852522
CHECKED BY _____

7.3.2 STRESS ANALYSIS

NUMBER OF ENGAGED THREADS :

$$N = .22 \times 20 = 4.4 \text{ THDS}$$

USE 3.0 FULL THDS

∴ THE FIRST THREAD WILL CARRY 50% OF THE LOAD

SHEAR AREA

$$A = .03802 \times 2\pi \times 1.7625$$

$$A = .421 \text{ IN}^2$$

AT BURST CONDITION

$$\gamma = \frac{F}{A} = \frac{23,200}{2 \times .421}$$

$$\gamma = 27,600 \text{ PSI O.K.}$$

FOR INCO 718

$$F_{50} = .6 \times 180 = 108 \text{ KSI}$$

$$\text{M.S. ULT} = \frac{.108}{27.6} - 1 =$$

291



DATE 6 MAR 73
PART NO. 852582
PREPARED BY MANUFACTO

CALC. NO. C6263 SHEET NO. 7-66
MODEL NO. 1/4 W. V. M.
CHECKED BY _____

7.4 SHIELD ASSY., VACUUM, HOT DISPLACER

COLLAPSING PRESSURE

$$R = \frac{1}{2} \times 5.955 + .020 = 2.998 \approx 3.00$$

$$t = .040 \text{ in.}$$

$$L = 5.45 + .03 = 5.48$$

$$REF, 5, PG. 126$$

$$Z = \left(\frac{L}{R} \right) \left(\frac{L}{t} \right) (1-\mu)^K = \frac{5.48^2}{3.00 \times .04} (1-.9)^K = 239.$$

$$\gamma_{cr} = \frac{c_p \pi^2 D}{R L^3} = \frac{c_p \pi^2 E t^3}{R L^3 12 (1-\mu^2)}$$

$$c_p = 20. \quad \text{FROM FIG. 4, PG 126.}$$

$$\gamma_{cr} = \frac{20. \pi^2 \times 29.8 \times 10^6 \times .04^3}{3.00 \times 5.48^3 \times 12 \times .91}$$

$$= \underline{\underline{384.951}} \quad >> 14.7$$



DATE 30 Aug 72
 PART NO. 852582
 PREPARED BY MSK/MTS

CALC. NO. C6263 SHEET NO. 7-67
 MODEL NO. 1/4-W. V.M.
 CHECKED BY _____

7.4 SHIELD ASSY, VACUUM, HOT DISPLACER

JUNCTION OF DOME AND CYLINDER

Hot spot stress

$$f_R = 1.128 \frac{a \cdot p}{t} \quad \text{For } \frac{a}{b} = 2 \quad \text{REF 3, page 49}$$

$$a = 3.00$$

$$t = .040$$

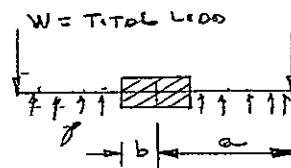
$$p = 14.7 \text{ psi}$$

$$f_R = \frac{1.128 \times 3.00 \times 14.7}{.040} = 1240 \text{ psi}$$

MAT'L: 302 STAINLESS, $F_{ty} = 30,000 \text{ psi}$

SUPPORT RING

ASSUME INNER EDGE FIXED AND SUPPORTED,
 OUTER EDGE FREE WITH LOAD W
 APPLIED AT OUTER EDGE AND p ACTING OVER
 AREA BETWEEN a & b .



$$a = 3.00$$

$$b = 1.850$$

$$t = 0.080$$

$$a/b = 1.65$$

$$\beta_{21} = .526$$

$$\beta_{22} = .599$$

$$W = 14.7 \times \pi \times 3.00 = 417 \text{ LBS.}$$

REF. 4, pg 215 & 216, case 22

$$f = \frac{\beta_{22} W}{t} - \frac{\beta_{21} p a^2}{t} = \frac{.526 \times 417}{.080} - \frac{.599 \times 14.7 \times 3.00^2}{.080} = 21,900 \text{ psi}$$

$$M.S. = \frac{30,000}{21,900} - 1 =$$

0.37



SECTION 8
COLD-END PRESSURE SHELL
STRESS ANALYSIS

DATE 21 JAN 74
PART NO. 852600
PREPARED BY MORRIS

CALC. NO. C 6263 SHEET NO. 8-1
MODEL NO. 1/4 x 1. V.M.
CHECKED BY _____

8. COLD END PRESSURE SHELL

8.1 TASKS

8.2 SHELL ANALYSIS

8.2.1 PRESSURE PLUS TEMPERATURE LOADING

8.2.2 VIBRATORY STRESSES

8.2.3 COMBINED PRESSURE, TEMPERATURE, AND VIBRATORY STRESSES

8.3 SHELL DEFLECTION

8.3.1 DUE TO SELF INDUCED VIBRATION LOADING

8.3.2 DUE TO VIBRATION LOADING,

8.4 FLANGE ASSY

8.5 VACUUM JACKET ASSY



DATE 21 JAN 74
PART NO. 852600
PREPARED BY MORIMOTO

CALC. NO. C6263 SHEET NO. 8-2
MODEL NO. 1/4 W.V.M.
CHECKED BY _____

8.1 TASKS

THE ANALYSIS OF THE COLD END PRESSURE SHELL CONSISTS OF THE FOLLOWING TASKS:

- DETERMINE SHELL STRESSES DUE TO INTERNAL PRESSURE, TEMPERATURE, AND VIBRATORY LOADING.
- DETERMINE TIP DEFLECTION DUE TO SELF INDUCED VIBRATION
- DETERMINE TIP DEFLECTION DUE TO VIBRATION LOADING
- DETERMINE NUT PRELOAD REQUIRED AT FLANGE ASSY
- STRESS ANALYZE FLANGE ASSY
- DETERMINE COLLAPSING PRESSURE AND STRESSES IN VACUUM JACKET ASSY.



DATE 21 JAN 74
PART NO. 852600
PREPARED BY MORNETS

CALC. NO. C 6263 SHEET NO. 8-3
MODEL NO. 1/4 W.V.M.
CHECKED BY _____

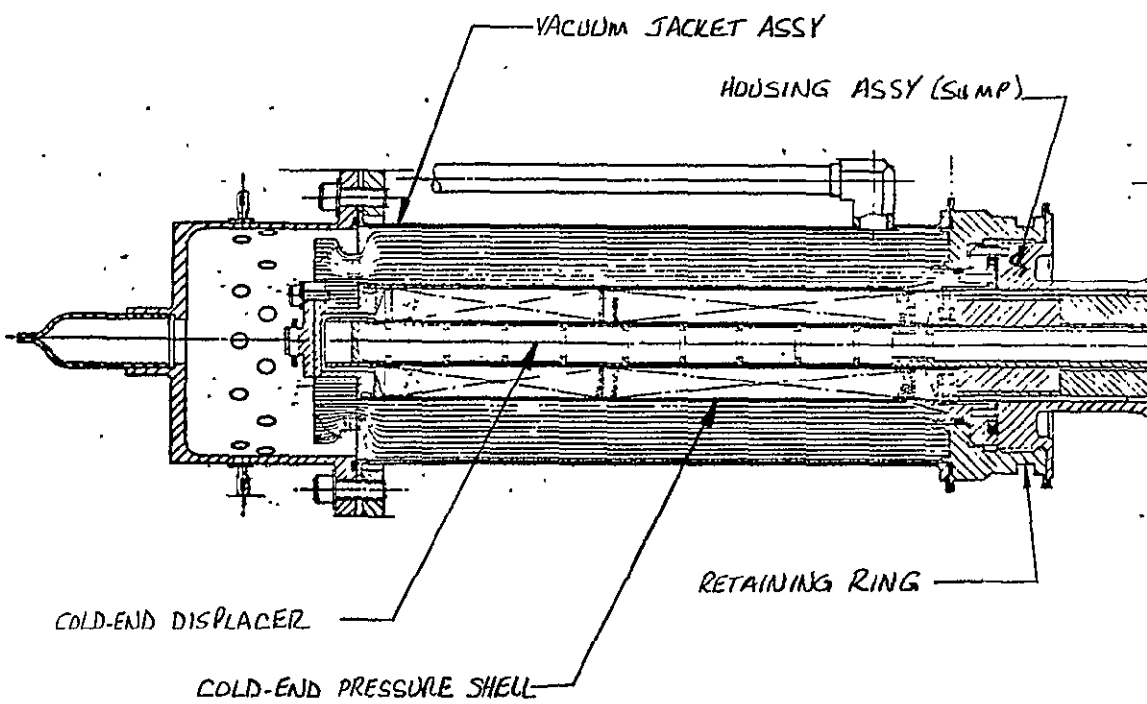


FIG. 8-1 COLD END ASSEMBLY



AIRRESEARCH MANUFACTURING COMPANY
OF CALIFORNIA

DATE 21 JAN 74
PART NO. 852600
PREPARED BY MORIMOTO

CALC. NO. C6263 SHEET NO. 8-4
MODEL NO. 1/4 W. V.M.
CHECKED BY _____

8.2 SHELL ANALYSIS

THE COLD END PRESSURE SHELL WAS ANALYZED USING A SHELL ANALYSIS PROGRAM DEVELOPED BY A. KALNIN. THE THEORETICAL BASIS FOR THE PROGRAM IS CONTAINED IN REF. (13).

THE SHELL ANALYSIS MODEL IS SHOWN ON THE NEXT PAGE.

THE SHELL WAS ANALYZED FOR 1250 PSI MAX OPERATING PRESSURE AND 2800 PSI BURST PRESSURE, PLUS A TEMPERATURE GRADIENT OF -343°F (65°K) AT THE COLD END AND 140°F AT THE FLANGE.

THE VIBRATORY STRESS DUE TO RANDOM VIBRATION LOADING OF 35.1 G'S WAS DETERMINED AND COMBINED WITH THE MAX OPERATING PRESSURE STRESS.

THE STRESSES ARE SHOWN ON PAGES 8-6 AND 8-7. THE MIN M.S. ARE 0.21 AT BURST AND 0.27 AT OPERATING PLUS VIBRATION.

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DATE 21 Jan 74
PART NO. 852600
PREPARED BY MGR1M578

CALC. NO. 06263 SHEET NO. 8-5
MODEL NO. 4 W. V. 17.
CHECKED BY _____

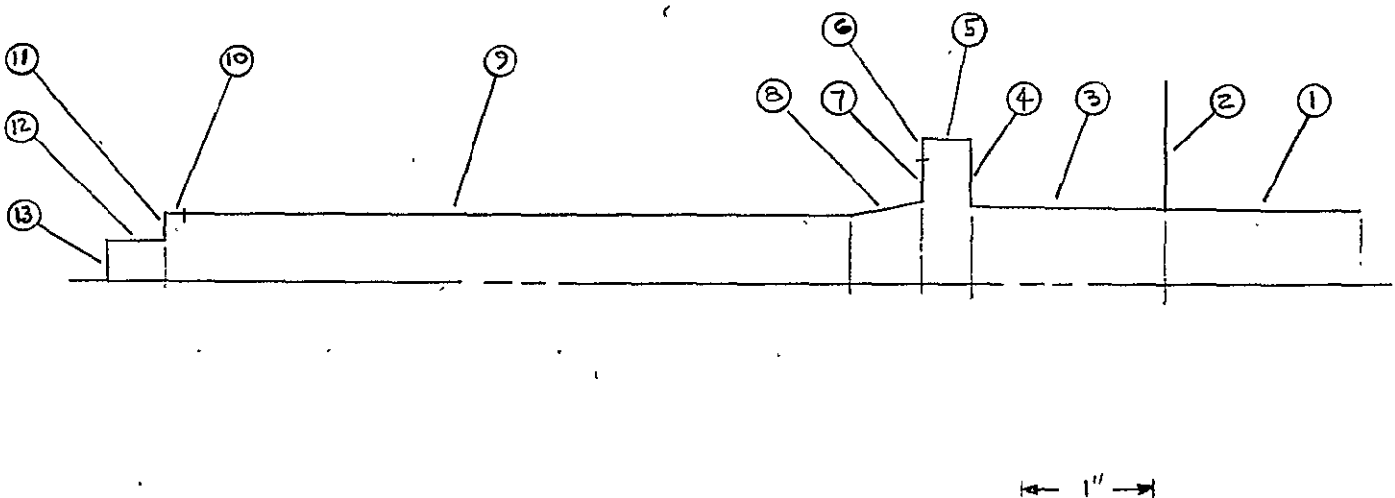


FIG. 8-2 COLD END PRESSURE SHELL MODEL



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OF CALIFORNIA

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DATE 21 JAN 74CALC. NO. C6263 SHEET NO. 8-6PART NO. 852600MODEL NO. 1/4 W.V.M.PREPARED BY MORIMOTO

CHECKED BY _____

8.2.1 PRESSURE PLUS TEMPERATURE STRESSES

THE SIGNIFICANT STRESSES COMPUTED BY THE PROGRAM ARE TABULATED BELOW. THE STRESSES FOR THE PARTS NOT LISTED ARE LOW; LESS THAN 80, KSI.

AT BURST PRESSURE:

PART NO.	f_L (KSI)	f_T (KSI)	$f_{comb.}$ ④ (KSI)	$F_{allow.}$ (KSI)	M.S.
1	145.	16.2	138.	175. ①	0.27
3	145.	16.2	138.	175.	0.27
8	125.	146.	137.	175.	0.28
9	125.	146.	137.	175.	0.28
10	104.	31.2	92.4	150. ③	0.62
12	226.	76.1	199.	240. ②	0.21
13	226.	76.1	199.	240.	0.21

NOTES: ① - F_{TU} AT 140°F② - F_{TU} AT -343°F (65°K)

③ - ALLOWABLE AT WELD

$$F_A = .90 \left[(F_{TU, \text{ANNEALED, R.T.}}) \times \frac{(F_{TU \text{ AT } -343^\circ\text{F}})}{(F_{TU \text{ AT R.T.}})} \right]$$

$$= .90 \times 125 \times 240 / 180$$

$$= 150, \text{ KSI}$$

$$④ - f_{comb.} = (f_L^2 + f_T^2 - f_L f_T - 3T^2)^{1/2} \quad (T=0)$$

AT MAX. OPERATING PRESSURE, THE STRESSES AT THE END OF PART 8 ARE:

$$f_L = 55.6 \text{ KSI}, \quad f_T = 65.2, \quad T=0$$

$$f_{comb} = 61.0 \text{ KSI}$$

THE MAX OPERATING STRESS WILL BE COMBINED WITH THE VIBRATORY STRESS IN PARAGRAPH 8.2.3.

THE COMPUTER OUTPUT IS INCLUDED IN THIS SECTION AS PAGES 8-8 THRU 8-40.



DATE 21 JAN 74
 PART NO. 852600
 PREPARED BY MORIMOTO

CALC. NO. C6263 SHEET NO. 8-7
 MODEL NO. 1/4 W.V.M.
 CHECKED BY _____

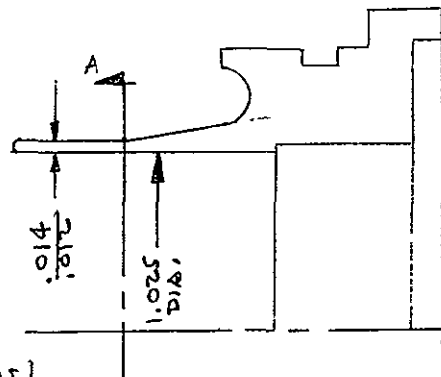
8.2.2 VIBRATORY STRESSES

BENDING STRESS

FROM SECTION 8.3 ,
 $f_n = 241. \text{ cps}$
 $L_{\text{Random}} = 35.0 \text{ g's}$

$M = 108.7 \text{ IN-LBS. FOR } 39.2 \text{ g's}$
 $= 97.1 \text{ IN-LBS FOR } 35.1 \text{ g's}$

(SEC. A-A IS 6.0 FROM END,
 BETWEEN STA 6 AND 7 OF VIB. ANALYSIS)



$$D_k = 1.025 + 2 \times 0.012 = 1.049 \text{ IN.}$$

$$I = \frac{\pi}{64} (1.049^4 - 1.025^4) = 5.26 \times 10^{-3} \text{ IN}^4$$

$$f = \frac{97.1 \times 5.245}{5.26 \times 10^{-3}} = 9,700. \text{ PSI}$$

8.2.3 COMBINED PRESSURE, TEMP., AND VIBRATORY STRESSES

FROM SECTION 8.2.1, PG 8-6, THE MAX OPERATING STRESS IS 61,000 PSI.

$$f = f_s + f_v = 61,000. + 9,700.$$

$$= 70,700. \text{ PSI}$$

THE FATIGUE ALLOWABLE FOR 10^8 CYCLES IS 90,000. PSI.
 (INCO 718)

$$M.S. = \frac{90,000.}{70,700.} - 1 =$$

0.27





AIRRESEARCH MANUFACTURING COMPANY
OF CALIFORNIA

Model Number 1000-1

KALNINS SHELL STRESS ANALYSIS.....COLD END PRESSURE SHELL 4 JAN 74

STATIC ANALYSIS PARTS= 13 BRANCHES= 1 NUMBER OF SUBCASES= 2

ANGLES OF ROTATION OF BOUNDARY CONDITIONS ARE ALFL= .00000 ALFRS= .00000 .00000

PART NO 1

SI= .00000 SX= .15000+01 IPAR= 6 INQ= 1 SHELL TYPE 2 NTP= 0 LAYERS MLV= 1

CYLINDRICAL SHELL NO 2 K= .00000 R= .57600+00 PHI= 90.000 DEGREES

LAYER NO 1 FROM Z= .45000+01 TO Z= .45000+01

CONSISTS OF ISOTROPIC MATERIAL, YOUNGS MODULUS E= .29800+08 POISSONS RATIO NU= .30000+00

COEFFICIENTS OF THERMAL EXPANSION AFI= .76000+05 ATHTA= .76000+05 MASS DENSITY RHO= .00000

PART NO 2

SI= .00000 SX= .97400+00 IPAR= 6 INQ= 1 SHELL TYPE 6 NTP= 2 LAYERS MLV= 1

CONICAL SHELL NO 6 K= .00000 PHI= .000 DEGREES A= .57600+00

LAYER NO 1 FROM Z= .15000+00 TO Z= .15000+00

CONSISTS OF ISOTROPIC MATERIAL, YOUNGS MODULUS E= .29800+08 POISSONS RATIO NU= .30000+00

COEFFICIENTS OF THERMAL EXPANSION AFI= .76000+05 ATHTA= .76000+05 MASS DENSITY RHO= .00000

PART NO 3

SI= .00000 SX= .15000+01 IPAR= 10 INQ= 1 SHELL TYPE 2 NTP= 0 LAYERS MLV= 1

CYLINDRICAL SHELL NO 2 K= .00000 R= .57600+00 PHI= 90.000 DEGREES

LAYER NO 1 FROM Z= .45000+01 TO Z= .45000+01

CONSISTS OF ISOTROPIC MATERIAL, YOUNGS MODULUS E= .29800+08 POISSONS RATIO NU= .30000+00

COEFFICIENTS OF THERMAL EXPANSION AFI= .76000+05 ATHTA= .76000+05 MASS DENSITY RHO= .00000

PART NO 4

SI= .00000 SX= .52400+00 IPAR= 6 INQ= 2 SHELL TYPE 6 NTP= 0 LAYERS MLV= 1

CONICAL SHELL NO 6 K= .00000 PHI= .000 DEGREES A= .57600+00

LAYER NO 1 FROM Z= .15000+00 TO Z= .15000+00

CONSISTS OF ISOTROPIC MATERIAL, YOUNGS MODULUS E= .29800+08 POISSONS RATIO NU= .30000+00

COEFFICIENTS OF THERMAL EXPANSION AFI= .76000+05 ATHTA= .76000+05 MASS DENSITY RHO= .00000

PART NO 5

SI= .00000 SX= .40000+00 IPAR= 4 INQ= 1 SHELL TYPE 2 NTP= 0 LAYERS MLV= 1

CYLINDRICAL SHELL NO 2 K= .00000 R= .11000+01 PHI= 90.000 DEGREES

LAYER NO 1 FROM Z= .10000+00 TO Z= .10000+00

CONSISTS OF ISOTROPIC MATERIAL, YOUNGS MODULUS E= .29800+08 POISSONS RATIO NU= .30000+00

COEFFICIENTS OF THERMAL EXPANSION AFI= .76000+05 ATHTA= .76000+05 MASS DENSITY RHO= .00000

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OF CALIFORNIA

PART NO 6

SI= .00000 SX= .35600-00 IPAR= 3 ING= 1 SHELL TYPE 6 NTP= 0 LAYERS MLY= 1

CONICAL SHELL NO 6 K= .00000 PHI= 180.000 DEGREES A= .11000+01

LAYER NO 1 FROM Z= .15000-00 TO Z= .15000-00

CONSISTS OF ISOTROPIC MATERIAL: YOUNGS MODULUS E= .29800+08 POISSONS RATIO NU= .30000-00

COEFFICIENTS OF THERMAL EXPANSION AFI= .76000-05 ATHEA= .76000-05 MASS DENSITY RHO= .00000

PART NO 7

SI= .00000 SX= .12700-00 IPAR= 7 ING= 1 SHELL TYPE 6 NTP= 0 LAYERS MLY= 1

CONICAL SHELL NO 6 K= .00000 PHI= 180.000 DEGREES A= .74400-00

LAYER NO 1 FROM Z= .15000-00 TO Z= .15000-00

CONSISTS OF ISOTROPIC MATERIAL: YOUNGS MODULUS E= .29800+08 POISSONS RATIO NU= .30000-00

COEFFICIENTS OF THERMAL EXPANSION AFI= .76000-05 ATHEA= .76000-05 MASS DENSITY RHO= .00000

PART NO 8

SI= .00000 SX= .70697-00 IPAR= 7 ING= 2 SHELL TYPE 6 NTP= 0 LAYERS MLY= 1

CONICAL SHELL NO 6 K= .00000 PHI= 98.050 DEGREES A= .44060+01

VARIABLE Z=COORDINATES OF THIS PART FOLLOW

ZI LINEAR FUNCTION GENERATOR NO. 1 FROM 2 POINTS

Y COORDINATES .6000-01 .6000-02

X COORDINATES .0000 .7070-00

Z0 LINEAR FUNCTION GENERATOR NO. 2 FROM 2 POINTS

Y COORDINATES .6000-01 .6000-02

X COORDINATES .0000 .7070-00

LAYER NO 1 FROM Z= .60000-01 TO Z= .12000-01

CONSISTS OF ISOTROPIC MATERIAL: YOUNGS MODULUS E= .29800+08 POISSONS RATIO NU= .30000-00

COEFFICIENTS OF THERMAL EXPANSION AFI= .76000-05 ATHEA= .76000-05 MASS DENSITY RHO= .00000

PART NO 9

SI= .00000 SX= .50750+01 IPAR= 25 ING= 1 SHELL TYPE 2 NTP= 0 LAYERS MLY= 1

CYLINDRICAL SHELL NO 2 K= .00000 R= .51800-00 PHI= 90.000 DEGREES

LAYER NO 1 FROM Z= .60000-02 TO Z= .60000-02

CONSISTS OF ISOTROPIC MATERIAL: YOUNGS MODULUS E= .29800+08 POISSONS RATIO NU= .30000-00

COEFFICIENTS OF THERMAL EXPANSION AFI= .76000-05 ATHEA= .76000-05 MASS DENSITY RHO= .00000

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Page 8-9



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OF CALIFORNIA

More Elements Form 1

PART NO 10

SI= .00000 SX= .12500=00 IPAR= 4 INC= 1 SHELL TYPE 2 NTP= 0 LAYERS HLY= 1

CYLINDRICAL SHELL NO 2 K= .00000 R= .51800=00 PHI= 90,000 DEGREES

LAYER NO 1 FROM Z= -.60000=02 TO Z= .14000=01

CONSISTS OF ISOTROPIC MATERIAL, YOUNGS MODULUS E= .29800+08 POISSONS RATIO NU= .30000=00

COEFFICIENTS OF THERMAL EXPANSION AFI= .76000=05 ATHTA= .76000=05 MASS DENSITY RHO= .00000

PART NO 11

SI= .00000 SX= .23040=00 IPAR= 8 INGW 1 SHELL TYPE 6 NTP= 0 LAYERS HLY= 1

CONICAL SHELL NO 6 K= .00000 PHI= 180,000 DEGREES A= .51800=00

LAYER NO 1 FROM Z= -.78000=01 TO Z= .78000=01

CONSISTS OF ISOTROPIC MATERIAL, YOUNGS MODULUS E= .29800+08 POISSONS RATIO NU= .30000=00

COEFFICIENTS OF THERMAL EXPANSION AFI= .76000=05 ATHTA= .76000=05 MASS DENSITY RHO= .00000

PART NO 12

SI= .00000 SX= .22000=00 IPAR= 8 INC= 1 SHELL TYPE 2 NTP= 0 LAYERS HLY= 1

CYLINDRICAL SHELL NO 2 K= .00000 R= .28760=00 PHI= 90,000 DEGREES

LAYER NO 1 FROM Z= -.12500=01 TO Z= .12500=01

CONSISTS OF ISOTROPIC MATERIAL, YOUNGS MODULUS E= .29800+08 POISSONS RATIO NU= .30000=00

COEFFICIENTS OF THERMAL EXPANSION AFI= .76000=05 ATHTA= .76000=05 MASS DENSITY RHO= .00000

PART NO 13

SI= .00000 SX= .23760=00 IPAR= 5 INC= 1 SHELL TYPE 6 NTP= 0 LAYERS HLY= 1

CONICAL SHELL NO 6 K= .00000 PHI= 180,000 DEGREES A= .28760=00

LAYER NO 1 FROM Z= -.17500=01 TO Z= .17500=01

CONSISTS OF ISOTROPIC MATERIAL, YOUNGS MODULUS E= .29800+08 POISSONS RATIO NU= .30000=00

COEFFICIENTS OF THERMAL EXPANSION AFI= .76000=05 ATHTA= .76000=05 MASS DENSITY RHO= .00000

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AIRSEARCH MANUFACTURING COMPANY
OF CALIFORNIA

Master Production Report, Inc.

KALVINS SHELL STRESS ANALYSIS.....COLD END PRESSURE SHELL 4 JAN 74

SUBCASE NO 1 FOR FOURIER HARMONIC COS 0 THETA

BOUNDARY CONDITIONS AT STARTING EDGE	1=	.00000	3=	.00000	5=	.00000	7=	.00000
BOUNDARY CONDITIONS AT FINAL EDGE	2=	.00000	4=	.00000	6=	.00000	8=	.00000
BOUNDARY CONDITION AT BRANCH EDGE NO 1	2=	.00000	3=	.00000	6=	.00000	8=	.00000

LOADS FOR PART NO 1 SUBCASE NO 1

RING LOADS AT END OF THIS PART ARE	Q=	.00000	NPHI=	.00000	MPHI=	.00000	N=	.00000
WK=	.00000	UK=	.00000	UTHK=	.00000			
SURFACE AND TEMP LOADS ARE	P=	.12500+04	PFI=	.00000	PTHETA=	.00000	TL=	.14000+03 TU= .14000+03

LOADS FOR PART NO 2 SUBCASE NO 1

RING LOADS AT END OF THIS PART ARE	Q=	.00000	NPHI=	.00000	MPHI=	.00000	N=	.00000
WK=	.00000	UK=	.00000	UTHK=	.00000			
SURFACE AND TEMP LOADS ARE	P=	.00000	PFI=	.00000	PTHETA=	.00000	TL=	.14000+03 TU= .14000+03

LOADS FOR PART NO 3 SUBCASE NO 1

RING LOADS AT END OF THIS PART ARE	Q=	.00000	NPHI=	.00000	MPHI=	.00000	N=	.00000
WK=	.00000	UK=	.00000	UTHK=	.00000			
SURFACE AND TEMP LOADS ARE	P=	.12500+04	PFI=	.00000	PTHETA=	.00000	TL=	.14000+03 TU= .14000+03

LOADS FOR PART NO 4 SUBCASE NO 1

RING LOADS AT END OF THIS PART ARE	Q=	.00000	NPHI=	.00000	MPHI=	.00000	N=	.00000
WK=	.00000	UK=	.00000	UTHK=	.00000			
SURFACE AND TEMP LOADS ARE	P=	.12500+04	PFI=	.00000	PTHETA=	.00000	TL=	.14000+03 TU= .14000+03

LOADS FOR PART NO 5 SUBCASE NO 1

RING LOADS AT END OF THIS PART ARE	Q=	.00000	NPHI=	.00000	MPHI=	.00000	N=	.00000
WK=	.00000	UK=	.00000	UTHK=	.00000			
SURFACE AND TEMP LOADS ARE	P=	.12500+04	PFI=	.00000	PTHETA=	.00000	TL=	.14000+03 TU= .14000+03

LOADS FOR PART NO 6 SUBCASE NO 1

RING LOADS AT END OF THIS PART ARE	Q=	.00000	NPHI=	.00000	MPHI=	.00000	N=	.00000
WK=	.00000	UK=	.00000	UTHK=	.00000			
SURFACE AND TEMP LOADS ARE	P=	.12500+04	PFI=	.00000	PTHETA=	.00000	TL=	.14000+03 TU= .14000+03

LOADS FOR PART NO 7 SUBCASE NO 1

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AIRSEARCH MANUFACTURING COMPANY
OF CALIFORNIA

RING LOADS AT END OF THIS PART ARE $Q = .00000$ $NPHI = .00000$ $MPHI = .00000$ $N = .00000$
 $WK = .00000$ $UK = .00000$ $UTHK = .00000$

SURFACE AND TEMP LOADS ARE $P = .12500+04$ $PFI = .00000$ $PTHETA = .00000$ $TL = .14000+03$ $TU = .14000+03$

LOADS FOR PART NO 8 SUBCASE NO 1

RING LOADS AT END OF THIS PART ARE $Q = .00000$ $NPHI = .00000$ $MPHI = .00000$ $N = .00000$
 $WK = .00000$ $UK = .00000$ $UTHK = .00000$

SURFACE AND TEMP LOADS ARE $P = .12500+04$ $PFI = .00000$ $PTHETA = .00000$ $TL = .14000+03$ $TU = .84000+02$

CODE NUMBERS OF VARIABLE LOADS OVER THIS PART, GIVEN BY FGNS BELOW, ARE 4 5

TI LINEAR FUNCTION GENERATOR NO. 3 FROM 2 POINTS

Y COORDINATES $.1400+03$ $.8400+02$

X COORDINATES $.0000$ $.7070+00$

TO LINEAR FUNCTION GENERATOR NO. 4 FROM 2 POINTS

Y COORDINATES $.1400+03$ $.8400+02$

X COORDINATES $.0000$ $.7070+00$

LOADS FOR PART NO 9 SUBCASE NO 1

RING LOADS AT END OF THIS PART ARE $Q = .00000$ $NPHI = .00000$ $MPHI = .00000$ $N = .00000$
 $WK = .00000$ $UK = .00000$ $UTHK = .00000$

SURFACE AND TEMP LOADS ARE $P = .12500+04$ $PFI = .00000$ $PTHETA = .00000$ $TL = .84000+02$ $TU = .34300+03$

CODE NUMBERS OF VARIABLE LOADS OVER THIS PART, GIVEN BY FGNS BELOW, ARE 4 5

TL LINEAR FUNCTION GENERATOR NO. 5 FROM 2 POINTS

Y COORDINATES $.8400+02$ $.3430+03$

X COORDINATES $.0000$ $.5075+01$

TU LINEAR FUNCTION GENERATOR NO. 6 FROM 2 POINTS

Y COORDINATES $.8400+02$ $.3430+03$

X COORDINATES $.0000$ $.5075+01$

LOADS FOR PART NO 10 SUBCASE NO 1

RING LOADS AT END OF THIS PART ARE $Q = .00000$ $NPHI = .00000$ $MPHI = .00000$ $N = .00000$
 $WK = .00000$ $UK = .00000$ $UTHK = .00000$

SURFACE AND TEMP LOADS ARE $P = .00000$ $PFI = .00000$ $PTHETA = .00000$ $TL = .34300+03$ $TU = .34300+03$

LOADS FOR PART NO 11 SUBCASE NO 1

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RING LOADS AT END OF THIS PART ARE Q= .00000 NPHI= .00000 MPHI= .00000 N= .00000
WK= .00000 UK= .00000 UTHK= .00000

SURFACE AND TEMP LOADS ARE P= .12500+04 PFI= .00000 PTHETA= .00000 TL= .34300+03 TU= .34300+03

LOADS FOR PART NO 12 SUBCASE NO 1

RING LOADS AT END OF THIS PART ARE Q= .00000 NPHI= .00000 MPHI= .00000 N= .00000
WK= .00000 UK= .00000 UTHK= .00000

SURFACE AND TEMP LOADS ARE P= .12500+04 PFI= .00000 PTHETA= .00000 TL= .34300+03 TU= .34300+03

LOADS FOR PART NO 13 SUBCASE NO 1

RING LOADS AT END OF THIS PART ARE Q= .00000 NPHI= .00000 MPHI= .00000 N= .00000
WK= .00000 UK= .00000 UTHK= .00000

SURFACE AND TEMP LOADS ARE P= .12500+04 PFI= .00000 PTHETA= .00000 TL= .34300+03 TU= .34300+03

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KALMINS SHELL STRESS ANALYSIS.....COLO END PRESSURE SHELL

4 JAN 74

DEFLECTIONS AND STRESS RESULTANTS FOR WAVE NUMBER NX= 0 OPERATING PRESSURE OF 1250 PSI PLUS TEMPERATURE LOADING

X	W	Q	UPHI	NPHI	BPHI	MPHI	UTHETA	N	NTHETA	MTHETA
MAIN SHELL PART NO 1										
.0000	.00000	.10658+04	.00000	.35729+03	.00000	-.94297+02	.00000	.00000	-.27465+04	-.28289+02
.2500	.53505+03	.39978+02	.34526+03	.35729+03	-.26140+02	.19068+02	.00000	.00000	-.25512+03	-.57205+01
.5000	.53502+03	.39949+02	.34526+03	.35729+03	-.26136+02	.19071+02	.00000	.00000	-.25529+03	.57214+01
.7500	.77170+03	-.65502+02	.63123+03	.35729+03	-.18778+03	.62521+01	.00000	.00000	.84678+03	.18756+01
.5000	.77167+03	-.65471+02	.63123+03	.35729+03	-.18735+03	.62617+01	.00000	.00000	.84660+03	.18785+01
.7500	.78458+03	.53791+01	.90583+03	.35729+03	-.82216+04	-.16183+01	.00000	.00000	.90673+03	-.48548+00
.7500	.78457+03	.53957+01	.90583+03	.35729+03	-.82098+04	-.16155+01	.00000	.00000	.90670+03	-.48466+00
1.0000	.79346+03	.10884+03	.11783+02	.35729+03	.29275+03	.11995+02	.00000	.00000	.94807+03	.35985+01
1.0000	.79344+03	.10885+03	.11783+02	.35729+03	.29296+03	.11999+02	.00000	.00000	.94801+03	.35997+01
1.2500	.37770+03	-.71888+02	.14691+02	.35729+03	.35540+02	.33547+02	.00000	.00000	-.96781+03	.10064+02
1.2500	.37770+03	-.71864+02	.14691+02	.35729+03	.35541+02	.33551+02	.00000	.00000	-.96780+03	.10065+02
1.5000	-.56520+03	-.18752+04	.18645+02	.35729+03	-.26041+06	-.16603+03	.00000	.00000	-.53782+04	-.49808+02
BRANCH SHELL PART NO 2										
.0000	-.18645+02	-.27383+03	-.56524+03	-.37507+04	-.69820+06	.50217+01	.00000	.00000	-.19410+05	-.66210+01
.1623	-.18644+02	-.21362+03	-.39553+03	-.68153+04	-.56886+06	.27396+01	.00000	.00000	-.16346+05	-.43441+01
.1623	-.18644+02	-.21362+03	-.39553+03	-.68153+04	-.56906+06	.27393+01	.00000	.00000	-.16346+05	-.43459+01
.3247	-.18643+02	-.17512+03	-.27780+03	-.83783+04	-.49131+06	.15744+01	.00000	.00000	-.14783+05	-.31852+01
.3247	-.18643+02	-.61035+04	-.27780+03	-.83783+04	-.49155+06	.15755+01	.00000	.00000	-.14783+05	-.31867+01
.4870	-.18643+02	-.51714+04	-.18823+03	-.92817+04	-.44172+06	.90289+02	.00000	.00000	-.13880+05	-.25153+01
.4870	-.18643+02	-.34332+04	-.18823+03	-.92817+04	-.44183+06	.90265+02	.00000	.00000	-.13880+05	-.25161+01
.6493	-.18642+02	-.29784+04	-.11562+03	-.98505+04	-.40883+06	.47924+02	.00000	.00000	-.13311+05	-.20933+01
.6493	-.18642+02	-.22888+04	-.11562+03	-.98505+04	-.40876+06	.48008+02	.00000	.00000	-.13311+05	-.20927+01
.8117	-.18641+02	-.20211+04	-.54034+04	-.10232+05	-.38668+06	.19637+02	.00000	.00000	-.12930+05	-.18095+01
.8117	-.18641+02	-.17166+04	-.54034+04	-.10232+05	-.38665+06	.19705+02	.00000	.00000	-.12930+05	-.18091+01
.9740	-.18641+02	-.15366+04	.76284+10	-.10499+05	-.37205+06	-.23104+04	.00000	.00000	-.12662+05	-.16101+01
MAIN SHELL PART NO 3										
.0000	-.56524+03	.18754+04	.18645+02	.35729+03	-.69820+06	-.16609+03	.00000	.00000	-.53784+04	-.49827+02
.1500	-.48103+04	.53269+03	.21185+02	.35729+03	-.47508+02	.61954+01	.00000	.00000	-.29704+04	.18586+01
.1500	-.48106+04	.53269+03	.21185+02	.35729+03	-.47507+02	.61968+01	.00000	.00000	-.29705+04	.18590+01
.3000	.53506+03	-.42071+02	.23231+02	.35729+03	-.26968+02	.34082+02	.00000	.00000	-.25507+03	-.10225+02
.3000	.53506+03	-.42073+02	.23231+02	.35729+03	-.26968+02	.34082+02	.00000	.00000	-.25508+03	-.10225+02
.4500	.77081+03	-.72191+03	.24957+02	.35729+03	-.65415+03	-.18258+02	.00000	.00000	-.84262+03	-.54774+01
.4500	.77081+03	-.12191+03	.24957+02	.35729+03	-.65415+03	.18258+02	.00000	.00000	-.84262+03	-.54774+01
.6000	.79672+03	-.62566+02	.26594+02	.35729+03	.12953+03	.40705+01	.00000	.00000	.96327+03	.12211+01
.6000	.79672+03	-.62575+02	.26594+02	.35729+03	.12950+03	.40693+01	.00000	.00000	.96327+03	.12208+01



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Model Number Form No. 1

.7500	.76793-03	.15938+02	.28239-02	.35729+03	.18727+03	.13677+01	.00000	.00000	.82919+03	.41030-00
.7500	.76793-03	.15939+02	.28239-02	.35729+03	.18726-03	.13678+01	.00000	.00000	.82919+03	.41033-00
.9000	.75050-03	.43970-00	.29904-02	.35729+03	.33717-04	.23295+01	.00000	.00000	.74804+03	.69884-00
.9000	.75050-03	.44514-00	.29904-02	.35729+03	.33701-04	.23301+01	.00000	.00000	.74804+03	.69902-00
1.0500	.75824-03	.90350+01	.31573-02	.35729+03	.13064-03	.18046+01	.00000	.00000	.78409+03	.54138-00
1.0500	.75824-03	.90329+01	.31573-02	.35729+03	.13064-03	.18048+01	.00000	.00000	.78409+03	.54145-00
1.2000	.78392-03	.40594+02	.33227-02	.35729+03	.17104-03	.15188+01	.00000	.00000	.90368+03	.45563-00
1.2000	.78392-03	.40590+02	.33227-02	.35729+03	.17105-03	.15183+01	.00000	.00000	.90368+03	.45550-00
1.3500	.78578-03	.96135+02	.34867-02	.35729+03	.27430-03	.11716+02	.00000	.00000	.91232+03	.35147+01
1.3500	.78578-03	.96132+02	.34867-02	.35729+03	.27429-03	.11715+02	.00000	.00000	.91232+03	.35146+01
1.5000	.84881-03	.85610+02	.36548-02	.35729+03	.17538-02	.27376+02	.00000	.00000	.27455+03	.82129+01
1.5000	.84881-03	.85610+02	.36548-02	.35729+03	.17538-02	.27376+02	.00000	.00000	.27455+03	.82129+01
MAIN SHELL PART NO 4										
.0000	.36548-02	.35729+03	.64881-03	.85608+02	.17537-02	.27376+02	.00000	.00000	.58366+03	.21236+03
.0437	.37309-02	.38477+03	.69495+03	.11947+03	.17310-02	.24135+02	.00000	.00000	.54980+03	.19454+03
.0873	.38060-02	.41223+03	.74128+03	.14686+03	.17084-02	.17970+02	.00000	.00000	.52240+03	.17808+03
.0873	.38060-02	.41223+03	.74128+03	.14686+03	.17084-02	.17970+02	.00000	.00000	.52240+03	.17808+03
.1310	.38801-02	.43966+03	.78777-03	.16934+03	.16842-02	.93436+01	.00000	.00000	.49992+03	.16253+03
.1747	.39531-02	.46708+03	.83438-03	.18801+03	.16566-02	.14109+01	.00000	.00000	.48125+03	.14754+03
.1747	.39531-02	.46708+03	.83438-03	.18801+03	.16566-02	.14109+01	.00000	.00000	.48125+03	.14754+03
.2183	.40247-02	.49449+03	.88111-03	.20369+03	.16243-02	.14049+02	.00000	.00000	.46558+03	.13289+03
.2620	.40948-02	.52188+03	.92793+03	.21698+03	.15860-02	.28388+02	.00000	.00000	.45229+03	.11838+03
.2620	.40948-02	.52188+03	.92793+03	.21698+03	.15860-02	.28388+02	.00000	.00000	.45229+03	.11838+03
.3057	.41631-02	.54927+03	.97482+03	.22835+03	.15407-02	.44291+02	.00000	.00000	.44092+03	.10388+03
.3493	.42293-02	.57664+03	.10218-02	.23814+03	.14874-02	.61650+02	.00000	.00000	.43113+03	.89283+02
.3493	.42293-02	.57664+03	.10218-02	.23814+03	.14874-02	.61650+02	.00000	.00000	.43113+03	.89283+02
.3930	.42929-02	.60401+03	.10688-02	.24664+03	.14252-02	.80382+02	.00000	.00000	.42263+03	.74504+02
.4367	.43536-02	.63137+03	.11159-02	.25407+03	.13533-02	.10042+03	.00000	.00000	.41520+03	.59479+02
.4367	.43536-02	.63137+03	.11159-02	.25407+03	.13533-02	.10042+03	.00000	.00000	.41520+03	.59479+02
.4803	.44109-02	.65873+03	.11630-02	.26059+03	.12709-02	.12172+03	.00000	.00000	.40868+03	.44156+02
.5240	.44644-02	.68608+03	.12101-02	.26635+03	.11773-02	.14422+03	.00000	.00000	.40292+03	.28494+02
.5240	.44644-02	.68608+03	.12101-02	.26635+03	.11773-02	.14422+03	.00000	.00000	.40292+03	.28494+02
MAIN SHELL PART NO 5										
.0000	.12101-02	.26635+03	.44644-02	.68608+03	.11773-02	.14422+03	.00000	.00000	.42116+03	.43267+02
.1000	.11236-02	.15584+03	.45815-02	.68608+03	.57006-03	.12276+03	.00000	.00000	.47758+02	.36828+02
.1000	.11236-02	.15584+03	.45815-02	.68608+03	.57007-03	.12276+03	.00000	.00000	.47758+02	.36828+02
.2000	.10938-02	.16942+02	.47002-02	.68608+03	.33111-04	.11400+03	.00000	.00000	.20937+03	.34199+02
.2000	.10938-02	.16942+02	.47002-02	.68608+03	.33111-04	.11400+03	.00000	.00000	.20937+03	.34199+02
.3000	.11167-02	.12365+03	.48190-02	.68608+03	.49613-03	.11943+03	.00000	.00000	.20936+03	.34200+02
.3000	.11167-02	.12365+03	.48190-02	.68608+03	.49613-03	.11943+03	.00000	.00000	.20936+03	.34200+02
.4000	.11949-02	.23958+03	.49364-02	.68608+03	.10811-02	.13792+03	.00000	.00000	.85065+02	.35829+02
.4000	.11949-02	.23958+03	.49364-02	.68608+03	.10811-02	.13792+03	.00000	.00000	.85065+02	.35829+02
MAIN SHELL PART NO 6										
.0000	.49364-02	.68608+03	.11949-02	.23961+03	.10810-02	.13792+03	.00000	.00000	.27069+03	.24520+02
.0000	.49364-02	.68608+03	.11949-02	.23961+03	.10810-02	.13792+03	.00000	.00000	.27069+03	.24520+02

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More Exact Parts, Inc.

.1187	.50782-02	.61174+03	.10665-02	.23562+03	.12950-02	.78285+02	.00000	.00000	.27468+03	.64995+02
.1187	.50782-02	.61174+03	.10665-02	.23562+03	.12950-02	.78285+02	.00000	.00000	.27468+03	.64995+02
.2373	.52407-02	.53735+03	.93828-03	.22988+03	.14320-02	.27660+02	.00000	.00000	.28042+03	.10300+03
.2373	.52407-02	.53735+03	.93828-03	.22988+03	.14320-02	.27660+02	.00000	.00000	.28043+03	.10300+03
.3560	.54157-02	.46290+03	.81015-03	.22118+03	.15080-02	.12764+02	.00000	.00000	.28913+03	.13973+03
MAIN SHELL PART NO 7										
.0000	.54157-02	.46290+03	.81015-03	.22119+03	.15080-02	.12764+02	.00000	.00000	.28915+03	.13973+03
.0181	.54431-02	.45151+03	.79058-03	.21947+03	.15154-02	.17919+02	.00000	.00000	.29087+03	.14536+03
.0181	.54431-02	.45151+03	.79058-03	.21947+03	.15154-02	.17919+02	.00000	.00000	.29087+03	.14536+03
.0363	.54706-02	.44011+03	.77101-03	.21762+03	.15220-02	.22771+02	.00000	.00000	.29273+03	.15102+03
.0363	.54706-02	.44011+03	.77101-03	.21762+03	.15220-02	.22771+02	.00000	.00000	.29273+03	.15102+03
.0544	.54983-02	.42872+03	.75145-03	.21562+03	.15277-02	.27308+02	.00000	.00000	.29473+03	.15673+03
.0544	.54983-02	.42872+03	.75145-03	.21562+03	.15277-02	.27308+02	.00000	.00000	.29473+03	.15673+03
.0726	.55261-02	.41731+03	.73189-03	.21345+03	.15327-02	.31511+02	.00000	.00000	.29690+03	.16251+03
.0726	.55261-02	.41731+03	.73189-03	.21345+03	.15327-02	.31511+02	.00000	.00000	.29690+03	.16251+03
.0907	.55539-02	.40591+03	.71233-03	.21110+03	.15370-02	.35364+02	.00000	.00000	.29924+03	.16836+03
.0907	.55539-02	.40591+03	.71233-03	.21110+03	.15370-02	.35364+02	.00000	.00000	.29924+03	.16836+03
.1089	.55818-02	.39450+03	.69279-03	.20855+03	.15409-02	.38845+02	.00000	.00000	.30180+03	.17432+03
.1089	.55818-02	.39450+03	.69279-03	.20855+03	.15409-02	.38845+02	.00000	.00000	.30180+03	.17432+03
.1270	.56096-02	.38309+03	.67325-03	.20577+03	.15444-02	.41931+02	.00000	.00000	.30458+03	.18041+03
.1270	.56096-02	.38309+03	.67325-03	.20577+03	.15444-02	.41931+02	.00000	.00000	.30458+03	.18041+03
MAIN SHELL PART NO 8										
.0000	.14522-02	.15009+03	.54603-02	.40813+03	.15444-02	.41931+02	.00000	.00000	.21959+03	.14083+02
.0505	.15190-02	.17738+03	.55172-02	.40750+03	.11009-02	.33798+02	.00000	.00000	.67618+03	.11028+02
.1010	.15637-02	.17381+03	.55710-02	.40250+03	.67812-03	.25060+02	.00000	.00000	.96538+03	.79653+01
.1010	.15637-02	.17381+03	.55710-02	.40250+03	.67809-03	.25062+02	.00000	.00000	.96540+03	.79658+01
.1515	.15882-02	.15119+03	.56223-02	.39480+03	.30247-03	.16968+02	.00000	.00000	.11150+04	.52507+01
.2020	.15954-02	.11938+03	.56715-02	.38581+03	.47156-05	.10226+02	.00000	.00000	.11568+04	.30660+01
.2020	.15954-02	.11939+03	.56715-02	.38581+03	.46124-05	.10225+02	.00000	.00000	.11567+04	.30655+01
.2525	.15892-02	.85010+02	.57191-02	.37658+03	.22717-03	.51107+01	.00000	.00000	.11233+04	.14599+01
.3030	.15741-02	.55865+02	.57654-02	.36783+03	.35316-03	.15814+01	.00000	.00000	.10459+04	.38879+00
.3030	.15741-02	.55901+02	.57654-02	.36784+03	.35308-03	.15797+01	.00000	.00000	.10459+04	.38831+00
.3535	.15553-02	.32099+02	.58107-02	.35998+03	.37231-03	.60890+00	.00000	.00000	.95101+03	.24826+00
.4040	.15385-02	.15317+02	.58552-02	.35310+03	.27217-03	.17881+01	.00000	.00000	.86033+03	.56987+00
.4040	.15385-02	.15322+02	.58552-02	.35310+03	.27223-03	.17878+01	.00000	.00000	.86034+03	.56980+00
.4545	.15302-02	.46945+01	.58991-02	.34710+03	.29303-04	.22895+01	.00000	.00000	.78956+03	.68924+00
.5050	.15387-02	.18500+01	.59425-02	.34168+03	.40596-03	.23718+01	.00000	.00000	.74836+03	.69107+00
.5050	.15388-02	.18501+01	.59425-02	.34168+03	.40555-03	.23705+01	.00000	.00000	.74839+03	.69083+00
.5555	.15761-02	.70978+01	.59851-02	.33643+03	.11343-02	.21670+01	.00000	.00000	.73993+03	.61835+00
.6060	.16612-02	.13879+02	.60272-02	.33097+03	.23351-02	.16677+01	.00000	.00000	.75790+03	.46883+00
.6060	.16612-02	.13877+02	.60272-02	.33097+03	.23332-02	.16666+01	.00000	.00000	.75786+03	.46852+00
.6565	.18220-02	.23639+02	.60688-02	.32509+03	.40937-02	.74282+00	.00000	.00000	.77220+03	.20207+00
.7070	.20480-02	.32088+02	.61127-02	.31939+03	.34990-02	.69627+00	.00000	.00000	.67651+03	.21294+00

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MAIN SHELL PART NO 9

.0000	.11710-02	.13004+02	.63392-02	.32073+03	.35056-02	.69420-00	.00000	.00000	.67629+03	.20826-00
.2030	.10553-02	.27098-00	.65216-02	.32073+03	.44944-03	.31308-01	.00000	.00000	.64288+03	.93923-02
.2030	.10589-02	.53587-00	.65215-02	.32073+03	.43669-03	.24206-01	.00000	.00000	.64534+03	.72617-02
.4060	.99190-03	.24218-00	.66837-02	.32073+03	.33954-03	.51319-02	.00000	.00000	.64552+03	.15396-02
.4060	.99491-03	.21626-01	.66836-02	.32073+03	.32895-03	.78116-03	.00000	.00000	.64760+03	.23435-03
.6090	.92814-03	.43836-01	.68191-02	.32073+03	.32804-03	.10456-02	.00000	.00000	.64793+03	.31367-03
.6090	.92762-03	.72966-02	.68191-02	.32073+03	.33053-03	.12233-03	.00000	.00000	.64757+03	.36698-04
.8120	.85776-03	.18682-00	.69284-02	.32073+03	.33899-03	.51319-02	.00000	.00000	.64576+03	.15396-02
.8120	.86032-03	.32053-02	.69283-02	.32073+03	.33100-03	.48754-04	.00000	.00000	.64752+03	.14626-04
1.0150	.79205-03	.76836-01	.70111-02	.32073+03	.33309-03	.22129-02	.00000	.00000	.64681+03	.66386-03
1.0150	.79313-03	.56887-02	.70111-02	.32073+03	.33064-03	.11741-03	.00000	.00000	.64756+03	.35222-04
1.2180	.72371-03	.15607-00	.70676-02	.32073+03	.33737-03	.43139-02	.00000	.00000	.64605+03	.12942-02
1.2180	.72582-03	.70666-02	.70676-02	.32073+03	.33109-03	.26695-04	.00000	.00000	.64752+03	.80086-05
1.4210	.65794-03	.47782-01	.70977-02	.32073+03	.33255-03	.13632-02	.00000	.00000	.64707+03	.40897-03
1.4210	.65864-03	.50421-02	.70977-02	.32073+03	.33070-03	.10591-03	.00000	.00000	.64755+03	.31772-04
1.6240	.58945-03	.13903-00	.71015-02	.32073+03	.33664-03	.38480-02	.00000	.00000	.64621+03	.11544-02
1.6240	.59142-03	.68169-02	.71015-02	.32073+03	.33054-03	.13075-03	.00000	.00000	.64757+03	.39225-04
1.8270	.52162-03	.18246-00	.70789-02	.32073+03	.33867-03	.50229-02	.00000	.00000	.64580+03	.15069-02
1.8270	.52413-03	.38013-02	.70789-02	.32073+03	.33091-03	.60588-04	.00000	.00000	.64753+03	.18176-04
2.0300	.45558-03	.94697-01	.70300-02	.32073+03	.33457-03	.26467-02	.00000	.00000	.64663+03	.79400-03
2.0300	.45690-03	.44079-02	.70299-02	.32073+03	.33081-03	.85895-04	.00000	.00000	.64754+03	.25768-04
2.2330	.38803-03	.11758-00	.69547-02	.32073+03	.33543-03	.52828-02	.00000	.00000	.64642+03	.98484-03
2.2330	.38963-03	.26493-02	.69546-02	.32073+03	.33102-03	.44979-04	.00000	.00000	.64752+03	.13494-04
2.4360	.32150-03	.66048-01	.68530-02	.32073+03	.33297-03	.18918-02	.00000	.00000	.64691+03	.56755-03
2.4360	.32240-03	.30761-02	.68530-02	.32073+03	.33096-03	.61600-04	.00000	.00000	.64753+03	.18480-04
2.6390	.25405-03	.81686-01	.67250-02	.32073+03	.33355-03	.23270-02	.00000	.00000	.64676+03	.69810-03
2.6390	.25513-03	.12779-02	.67250-02	.32073+03	.33117-03	.20216-04	.00000	.00000	.64751+03	.60648-05
2.8420	.18751-03	.29825-01	.65707-02	.32073+03	.33126-03	.91191-03	.00000	.00000	.64725+03	.27357-03
2.8420	.18790-03	.13680-02	.65707-02	.32073+03	.33114-03	.30632-04	.00000	.00000	.64751+03	.91897-05
3.0450	.12019-03	.36226-01	.63900-02	.32073+03	.33140-03	.10978-02	.00000	.00000	.64719+03	.32934-03
3.0450	.12063-03	.14305-05	.63900-02	.32073+03	.33130-03	.14646-05	.00000	.00000	.64750+03	.43939-06
3.2480	.53489-04	.35717-02	.61829-02	.32073+03	.32966-03	.11151-04	.00000	.00000	.64756+03	.33454-05
3.2480	.53393-04	.15736-03	.61829-02	.32073+03	.33131-03	.22466-05	.00000	.00000	.64750+03	.67397-06
3.4510	.13728-04	.48179-02	.59495-02	.32073+03	.32937-03	.46335-05	.00000	.00000	.64758+03	.13901-05
3.4510	.13865-04	.12926-02	.59495-02	.32073+03	.33143-03	.23339-04	.00000	.00000	.64749+03	.70016-05
3.6540	.80542-04	.36802-01	.56898-02	.32073+03	.32822-03	.89694-03	.00000	.00000	.64787+03	.26908-03
3.6540	.81110-04	.16881-02	.56898-02	.32073+03	.33147-03	.26823-04	.00000	.00000	.64748+03	.80469-05
3.8570	.14765-03	.45823-01	.54037-02	.32073+03	.32761-03	.11261-02	.00000	.00000	.64796+03	.33783-03

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AIRSEARCH MANUFACTURING COMPANY
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More Detail Form, Inc. 1

3.8570	+.14836-03	+.22698-02	+.58037-02	+.32073+03	+.33155-03	+.37310-04	.00000	.00000	.64748+03	+.11193-04
4.0600	+.21466-03	+.61954-01	+.50912-02	+.32073+03	+.32649-03	+.15350-02	.00000	.00000	.64812+03	+.46050-03
4.0600	+.21561-03	+.29007-02	+.50912-02	+.32073+03	+.33161-03	+.49280-04	.00000	.00000	.64747+03	+.14784-04
4.2630	+.28167-03	+.78911-01	+.47524-02	+.32073+03	+.32576-03	+.19989-02	.00000	.00000	.64828+03	+.99968-03
4.2630	+.28285-03	+.32578-02	+.47524-02	+.32073+03	+.33165-03	+.53813-04	.00000	.00000	.64747+03	+.16144-04
4.4660	+.34878-03	+.87889-01	+.43873-02	+.32073+03	+.32509-03	+.22224-02	.00000	.00000	.64837+03	+.66673-03
4.4660	+.35009-03	+.39346-02	+.43873-02	+.32073+03	+.33126-03	+.10318-03	.00000	.00000	.64747+03	+.30955-04
4.6690	+.41622-03	+.10102+00	+.39957-02	+.32073+03	+.33686-03	+.35300-02	.00000	.00000	.64823+03	+.10590-02
4.6690	+.41807-03	+.28706-01	+.39958-02	+.32073+03	+.34548-03	+.23631-03	.00000	.00000	.64696+03	+.70892-04
4.8720	+.46292-03	+.93099-00	+.35775-02	+.32073+03	+.19805-05	+.29330-02	.00000	.00000	.66242+03	+.87989-03
4.8720	+.46519-03	+.77032-00	+.35776-02	+.32073+03	+.83896-05	+.11724-02	.00000	.00000	.66085+03	+.35173-03
5.0750	+.10759-02	+.24528-02	+.31444-02	+.32073+03	+.76382-02	+.19044+00	.00000	.00000	.28566+03	+.57132-01
MAIN SHELL PART NO 10										
.0000	+.10781-02	+.24686-02	+.31445-02	+.32073+03	+.76481-02	+.19449+00	.00000	.00000	.40939+03	+.11943-01
.0313	+.12796-02	+.74363-01	+.30854-02	+.32073+03	+.51362-02	+.65993-00	.00000	.00000	.17758+03	+.12748-00
.0313	+.12796-02	+.74363-01	+.30854-02	+.32073+03	+.51362-02	+.65993-00	.00000	.00000	.17758+03	+.12748-00
.0625	+.13954-02	+.12653-01	+.30307-02	+.32073+03	+.22502-02	+.77494-00	.00000	.00000	.44316+02	+.44010-00
.0625	+.13954-02	+.12653-01	+.30307-02	+.32073+03	+.22502-02	+.77494-00	.00000	.00000	.44316+02	+.44010-00
.0938	+.14195-02	+.36175-01	+.29775-02	+.32073+03	+.71179-03	+.78979-00	.00000	.00000	.16575+02	+.55552-00
.0938	+.14195-02	+.36175-01	+.29775-02	+.32073+03	+.71179-03	+.78979-00	.00000	.00000	.16575+02	+.55552-00
.1250	+.13511-02	+.28839-01	+.29239-02	+.32073+03	+.36639-02	+.75637-00	.00000	.00000	.16577+02	+.55548-00
.1250	+.13511-02	+.28839-01	+.29239-02	+.32073+03	+.36639-02	+.75637-00	.00000	.00000	.16577+02	+.55548-00
MAIN SHELL PART NO 11										
.0000	+.29239-02	+.32073+03	+.13511-02	+.28891+01	+.36637-02	+.75628-00	.00000	.00000	+.76545+01	+.66454+02
.0288	+.30303-02	+.30256+03	+.12760-02	+.26003+01	+.37219-02	+.43363+01	.00000	.00000	+.79429+01	+.73029+02
.0288	+.30303-02	+.30256+03	+.12760-02	+.26004+01	+.37219-02	+.43363+01	.00000	.00000	+.79448+01	+.73029+02
.0576	+.31382-02	+.28436+03	+.12009-02	+.22557+01	+.37720-02	+.85474+01	.00000	.00000	+.82888+01	+.79805+02
.0576	+.31382-02	+.28436+03	+.12009-02	+.22557+01	+.37720-02	+.85474+01	.00000	.00000	+.82888+01	+.79805+02
.0864	+.32475-02	+.26613+03	+.11259-02	+.18397+01	+.38171-02	+.11752+02	.00000	.00000	+.87041+01	+.86905+02
.0864	+.32475-02	+.26613+03	+.11259-02	+.18397+01	+.38171-02	+.11752+02	.00000	.00000	+.87041+01	+.86905+02
.1152	+.33581-02	+.24787+03	+.10508-02	+.13314+01	+.38608-02	+.13780+02	.00000	.00000	+.87034+01	+.86905+02
.1152	+.33581-02	+.24787+03	+.10508-02	+.13314+01	+.38608-02	+.13780+02	.00000	.00000	+.87034+01	+.86905+02
.1440	+.34699-02	+.22957+03	+.97572-03	+.70119-00	+.39078-02	+.14393+02	.00000	.00000	+.92109+01	+.94499+02
.1440	+.34699-02	+.22957+03	+.97572-03	+.70119-00	+.39078-02	+.14393+02	.00000	.00000	+.92109+01	+.94499+02
.1728	+.35833-02	+.21122+03	+.90066-03	+.93060-01	+.39635-02	+.13248+02	.00000	.00000	+.98401+01	+.10282+03
.1728	+.35833-02	+.21122+03	+.90066-03	+.93060-01	+.39635-02	+.13248+02	.00000	.00000	+.98401+01	+.10282+03
.2016	+.36984-02	+.19281+03	+.82561-03	+.11139+01	+.40353-02	+.98415+01	.00000	.00000	+.10633+02	+.11222+03
.2016	+.36984-02	+.19281+03	+.82561-03	+.11139+01	+.40353-02	+.98415+01	.00000	.00000	+.10633+02	+.11222+03
.2304	+.38159-02	+.17432+03	+.75057-03	+.24563+01	+.41329-02	+.34041+01	.00000	.00000	+.11652+02	+.12319+03
.2304	+.38159-02	+.17432+03	+.75057-03	+.24563+01	+.41329-02	+.34041+01	.00000	.00000	+.11652+02	+.12319+03

MAIN SHELL PART NO 12

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.0000	.75057-03	.24562-01	.38159-02	.17432+03	.41329-02	.34041+01	.00000	.00000	.50095+02	.10212+01
.0275	.66640-03	.20420+02	.37488-02	.17432+03	.20281-02	.30418+01	.00000	.00000	.26812+03	.91254+00
.0275	.66640-03	.20420+02	.37488-02	.17432+03	.20281-02	.30418+01	.00000	.00000	.26812+03	.91254+00
.0550	.63581-03	.24368+02	.36800-02	.17432+03	.26493+03	.24087+01	.00000	.00000	.34736+03	.72260+00
.0550	.63581-03	.24368+02	.36800-02	.17432+03	.26493+03	.24087+01	.00000	.00000	.34736+03	.72260+00
.0825	.64788-03	.26267+02	.36110-02	.17432+03	.10688+02	.17194+01	.00000	.00000	.31609+03	.51582+00
.0825	.64788-03	.26267+02	.36110-02	.17432+03	.10688+02	.17194+01	.00000	.00000	.31609+03	.51582+00
.1100	.69027-03	.35172+02	.35428-02	.17432+03	.19263+02	.89901+00	.00000	.00000	.20628+03	.26975+00
.1100	.69027-03	.35172+02	.35428-02	.17432+03	.19263+02	.89901+00	.00000	.00000	.20628+03	.26975+00
.1375	.74801-03	.56839+02	.34761-02	.17432+03	.21409+02	.33291+00	.00000	.00000	.56723+02	.99872+01
.1375	.74801-03	.56839+02	.34761-02	.17432+03	.21409+02	.33291+00	.00000	.00000	.56723+02	.99872+01
.1650	.79867-03	.92514+02	.34110-02	.17432+03	.13264+02	.23571+01	.00000	.00000	.74514+02	.70712+00
.1650	.79867-03	.92514+02	.34110-02	.17432+03	.13264+02	.23571+01	.00000	.00000	.74514+02	.70712+00
.1925	.80585-03	.13629+03	.33468-02	.17432+03	.11416+02	.54983+01	.00000	.00000	.93113+02	.16495+01
.1925	.80585-03	.13629+03	.33468-02	.17432+03	.11416+02	.54983+01	.00000	.00000	.93113+02	.16495+01
.2200	.71378-03	.17092+03	.32816-02	.17432+03	.60150+02	.97742+01	.00000	.00000	.14539+03	.29323+01
.2200	.71378-03	.17092+03	.32816-02	.17432+03	.60150+02	.97742+01	.00000	.00000	.14539+03	.29323+01
MAIN SHELL PART NO 13										
.0000	.32816-02	.17432+03	.71379-03	.17091+03	.60144-02	.97736+01	.00000	.00000	.18157+03	.70549+00
.0475	.36500-02	.14354+03	.59516-03	.16859+03	.91131-02	.36159+01	.00000	.00000	.18389+03	.29568+01
.0475	.36500-02	.14354+03	.59516-03	.16859+03	.91131-02	.36159+01	.00000	.00000	.18389+03	.29568+01
.0950	.41158-02	.11224+03	.47634-03	.16435+03	.10201-01	.12344+01	.00000	.00000	.18813+03	.60106+01
.0950	.41158-02	.11224+03	.47634-03	.16435+03	.10201-01	.12344+01	.00000	.00000	.18813+03	.60106+01
.1426	.45962-02	.79877+02	.35715-03	.15528+03	.98190-02	.45989+01	.00000	.00000	.19720+03	.85877+01
.1426	.45962-02	.79877+02	.35715-03	.15528+03	.98190-02	.45989+01	.00000	.00000	.19720+03	.85877+01
.1901	.50373-02	.44928+02	.23705-03	.12987+03	.87076-02	.58117+01	.00000	.00000	.22260+03	.11251+02
.1901	.50373-02	.44928+02	.23705-03	.12987+03	.87076-02	.58117+01	.00000	.00000	.22260+03	.11251+02
.2376	.54384-02	.56028+05	.11345-03	.30794+00	.87042-02	.53432-02	.00000	.00000	.35231+03	.18534+02
.2376	.54384-02	.56028+05	.11345-03	.30794+00	.87042-02	.53432-02	.00000	.00000	.35231+03	.18534+02

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AIRSEARCH MANUFACTURING COMPANY
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KALMING SHELL STRESS ANALYSIS.....COLO END PRESSURE SHELL

4 JAN 74

DEFLECTIONS AND STRESSES FOR WAVE NUMBER NX= 0

OPERATING PRESSURE OF 1250 PSI PLUS TEMPERATURE LOADING

X	W	UPHI	UTHEA	BPHI	SPHI IN	SPHI OUT	STHTA IN	STHTA OUT	SFIH IN	SFIH OUT
MAIN SHELL PART NO 1										
.0000	.00000	.00000	.00000	.00000	.73819+05	.65880+05	.95614+04	.51471+05	.00000	.00000
.2500	.53505+03	.34526+03	.00000	.20140+02	.10155+05	.18095+05	.70721+04	.14028+04	.00000	.00000
.2500	.53502+03	.34526+03	.00000	.20136+02	.10157+05	.18097+05	.70746+04	.14015+04	.00000	.00000
.5000	.77170+03	.63123+03	.00000	.18778+03	.66135+03	.86010+04	.80193+04	.10798+05	.00000	.00000
.5000	.77167+03	.63123+03	.00000	.18735+03	.66044+03	.86081+04	.80152+04	.10798+05	.00000	.00000
.7500	.78458+03	.90583+03	.00000	.82216+04	.51686+04	.27711+04	.10434+05	.97151+04	.00000	.00000
.7500	.78457+03	.90583+03	.00000	.82098+04	.51665+04	.27732+04	.10433+05	.97154+04	.00000	.00000
1.0000	.79346+03	.11783+02	.00000	.29275+03	.49152+04	.12855+05	.78686+04	.13200+05	.00000	.00000
1.0000	.79344+03	.11783+02	.00000	.29296+03	.49182+04	.12858+05	.78671+04	.13200+05	.00000	.00000
1.2500	.37770+03	.14691+02	.00000	.35540+02	.20880+05	.28820+05	.18431+05	.35207+04	.00000	.00000
1.2500	.37770+03	.14691+02	.00000	.35541+02	.20883+05	.28822+05	.18431+05	.35198+04	.00000	.00000
1.5000	.56520+03	.18645+02	.00000	.26041+06	.12695+06	.11901+06	.22863+05	.96652+05	.00000	.00000
BRANCH SHELL PART NO 2										
.0000	.18645+02	.56524+03	.00000	.69820+06	.12506+05	.12499+05	.64697+05	.64706+05	.00000	.00000
.1623	.18644+02	.39553+03	.00000	.56886+06	.22719+05	.22716+05	.54484+05	.54489+05	.00000	.00000
.1623	.18644+02	.39553+03	.00000	.56906+06	.22719+05	.22716+05	.54484+05	.54489+05	.00000	.00000
.3247	.18643+02	.27780+03	.00000	.49131+06	.27929+05	.27927+05	.49275+05	.49279+05	.00000	.00000
.3247	.18643+02	.27780+03	.00000	.49135+06	.27929+05	.27927+05	.49275+05	.49279+05	.00000	.00000
.4870	.18643+02	.18823+03	.00000	.44172+06	.30940+05	.30938+05	.46268+05	.46267+05	.00000	.00000
.4870	.18643+02	.18823+03	.00000	.44183+06	.30940+05	.30938+05	.46264+05	.46267+05	.00000	.00000
.6493	.18642+02	.11562+03	.00000	.40883+06	.32835+05	.32835+05	.44368+05	.44371+05	.00000	.00000
.6493	.18642+02	.11562+03	.00000	.40876+06	.32835+05	.32835+05	.44368+05	.44371+05	.00000	.00000
.8117	.18641+02	.54034+04	.00000	.38668+06	.34106+05	.34105+05	.43098+05	.43100+05	.00000	.00000
.8117	.18641+02	.54034+04	.00000	.38665+06	.34106+05	.34105+05	.43098+05	.43100+05	.00000	.00000
.9740	.18641+02	.76284+10	.00000	.37205+06	.34998+05	.34998+05	.42206+05	.42208+05	.00000	.00000
MAIN SHELL PART NO 3										
.0000	.56524+03	.18645+02	.00000	.69820+06	.12700+06	.11906+06	.22851+05	.96669+05	.00000	.00000
.1500	.48103+04	.21185+02	.00000	.47508+02	.61932+03	.85500+04	.34382+05	.31628+05	.00000	.00000
.1500	.48106+04	.21185+02	.00000	.47507+02	.62038+03	.85601+04	.34382+05	.31628+05	.00000	.00000
.3000	.53506+03	.23231+02	.00000	.26968+02	.21276+05	.29216+05	.10408+05	.47397+04	.00000	.00000
.3000	.53506+03	.23231+02	.00000	.26968+02	.21276+05	.29216+05	.10408+05	.47396+04	.00000	.00000
.4500	.77081+03	.24957+02	.00000	.65415+03	.95545+04	.17494+05	.53051+04	.13420+05	.00000	.00000
.4500	.77081+03	.24957+02	.00000	.65415+03	.95547+04	.17494+05	.53051+04	.13420+05	.00000	.00000
.6000	.79672+03	.26594+02	.00000	.12953+03	.95466+03	.69850+04	.97984+04	.11608+05	.00000	.00000
.6000	.79672+03	.26594+02	.00000	.12950+03	.95555+03	.69841+04	.97988+04	.11607+05	.00000	.00000

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.7500	.76793+03	.28239+02	.00000	.18727+03	.49829+04	.29568+04	.95172+04	.89093+04	.00000	.00000
.7500	.76793+03	.28239+02	.00000	.18726+03	.49830+04	.29567+04	.95172+04	.89093+04	.00000	.00000
.9000	.75050+03	.29900+02	.00000	.33717+04	.56954+04	.22443+04	.88292+04	.77938+04	.00000	.00000
.9000	.75050+03	.29900+02	.00000	.33701+04	.56958+04	.22439+04	.88293+04	.77937+04	.00000	.00000
1.0500	.75824+03	.31573+02	.00000	.13064+03	.53066+04	.26331+04	.91131+04	.83111+04	.00000	.00000
1.0500	.75824+03	.31573+02	.00000	.13064+03	.53068+04	.26329+04	.91132+04	.83111+04	.00000	.00000
1.2000	.78392+03	.33227+02	.00000	.17104+03	.28448+04	.50949+04	.97034+04	.10378+05	.00000	.00000
1.2000	.78392+03	.33227+02	.00000	.17105+03	.28452+04	.50945+04	.97035+04	.10378+05	.00000	.00000
1.3500	.78578+03	.34867+02	.00000	.27430+03	.47085+04	.12648+05	.75333+04	.12740+05	.00000	.00000
1.3500	.78578+03	.34867+02	.00000	.27429+03	.47082+04	.12648+05	.75335+04	.12740+05	.00000	.00000
1.5000	.84881+03	.36548+02	.00000	.17538+02	.16309+05	.24249+05	.36331+04	.91342+04	.00000	.00000
MAIN SHELL PART NO 4										
.0000	.36548+02	.64881+03	.00000	.17537+02	.15397+04	.21104+04	.12212+05	.16103+05	.00000	.00000
.0437	.37309+02	.64995+03	.00000	.17310+02	.12108+04	.20073+04	.11136+05	.14802+05	.00000	.00000
.0873	.38060+02	.74128+03	.00000	.17084+02	.70845+03	.16875+04	.10131+05	.13613+05	.00000	.00000
.0873	.38060+02	.74128+03	.00000	.17084+02	.70847+03	.16876+04	.10131+05	.13613+05	.00000	.00000
.1310	.38801+02	.78777+03	.00000	.16842+02	.58432+02	.11874+04	.91687+04	.12502+05	.00000	.00000
.1747	.39531+02	.83438+03	.00000	.16566+02	.72077+03	.53265+03	.82321+04	.11440+05	.00000	.00000
.1747	.39531+02	.83438+03	.00000	.16566+02	.72077+03	.53266+03	.82321+04	.11441+05	.00000	.00000
.2183	.40247+02	.88111+03	.00000	.16243+02	.16156+04	.25763+03	.73074+04	.10411+05	.00000	.00000
.2620	.40948+02	.92793+03	.00000	.15860+02	.26158+04	.26158+04	.63845+04	.93997+04	.00000	.00000
.2620	.40948+02	.92793+03	.00000	.15860+02	.26158+04	.11693+04	.63845+04	.93997+04	.00000	.00000
.3057	.41631+02	.97482+03	.00000	.15407+02	.37139+04	.21916+04	.54557+04	.83952+04	.00000	.00000
.3493	.42293+02	.10218+02	.00000	.14874+02	.49038+04	.33162+04	.45151+04	.73893+04	.00000	.00000
.3493	.42293+02	.10218+02	.00000	.14874+02	.49038+04	.33162+04	.45151+04	.73893+04	.00000	.00000
.3930	.42929+02	.10688+02	.00000	.14252+02	.61809+04	.45366+04	.35582+04	.63757+04	.00000	.00000
.4367	.43536+02	.11159+02	.00000	.13533+02	.75416+04	.58479+04	.25813+04	.53493+04	.00000	.00000
.4367	.43536+02	.11159+02	.00000	.13533+02	.75416+04	.58479+04	.25813+04	.53493+04	.00000	.00000
.4803	.44109+02	.11630+02	.00000	.12709+02	.89830+04	.72458+04	.15815+04	.43060+04	.00000	.00000
.5240	.44644+02	.12101+02	.00000	.11773+02	.10503+05	.87271+04	.55655+03	.32427+04	.00000	.00000
MAIN SHELL PART NO 5										
.0000	.12101+02	.44644+02	.00000	.11773+02	.25064+05	.18203+05	.85959+04	.43843+04	.00000	.00000
.1000	.11236+02	.45815+02	.00000	.57006+03	.21844+05	.14984+05	.52854+04	.57630+04	.00000	.00000
.1000	.11236+02	.45815+02	.00000	.57007+03	.21844+05	.14984+05	.52854+04	.57630+04	.00000	.00000
.2000	.10938+02	.47002+02	.00000	.33111+04	.20530+05	.13669+05	.40830+04	.61767+04	.00000	.00000
.2000	.10938+02	.47002+02	.00000	.33141+04	.20530+05	.13670+05	.40832+04	.61768+04	.00000	.00000
.3000	.11167+02	.48190+02	.00000	.49613+03	.21345+05	.14484+05	.49491+04	.57997+04	.00000	.00000
.3000	.11167+02	.48190+02	.00000	.49610+03	.21345+05	.14484+05	.49491+04	.57997+04	.00000	.00000
.4000	.11949+02	.49364+02	.00000	.10811+02	.24118+05	.17257+05	.78981+04	.45143+04	.00000	.00000
MAIN SHELL PART NO 6										
.0000	.49364+02	.11949+02	.00000	.10810+02	.99931+04	.83957+04	.73236+03	.25370+04	.00000	.00000

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.1187	.50782-02	.10665-02	.00000	.12950-02	.60044+04	.44336+04	.34174+04	.52486+04	.00000	.00000
.1187	.50782-02	.10665-02	.00000	.12950-02	.60044+04	.44336+04	.34174+04	.52486+04	.00000	.00000
.2373	.52407-02	.93828-03	.00000	.14320-02	.26103+04	.10778+04	.59323+04	.78018+04	.00000	.00000
.2373	.52407-02	.93828-03	.00000	.14320-02	.26103+04	.10778+04	.59323+04	.78018+04	.00000	.00000
.3560	.54157-02	.81015-03	.00000	.15080-02	.11362+03	.15882+04	.83518+04	.10279+05	.00000	.00000
.3560	.54157-02	.81015-03	.00000	.15080-02	.11362+03	.15882+04	.83518+04	.10279+05	.00000	.00000
MAIN SHELL PART NO 7										
.0000	.54157-02	.81015-03	.00000	.15080-02	.11359+03	.15882+04	.83518+04	.10279+05	.00000	.00000
.0181	.54431-02	.79058-03	.00000	.15154-02	.46300+03	.19262+04	.87213+04	.10660+05	.00000	.00000
.0181	.54431-02	.79058-03	.00000	.15154-02	.46300+03	.19262+04	.87213+04	.10660+05	.00000	.00000
.0363	.54706-02	.77101-03	.00000	.15220-02	.79269+03	.22435+04	.90926+04	.11044+05	.00000	.00000
.0363	.54706-02	.77101-03	.00000	.15220-02	.79269+03	.22435+04	.90926+04	.11044+05	.00000	.00000
.0544	.54983-02	.75145-03	.00000	.15277-02	.11018+04	.25392+04	.94665+04	.11431+05	.00000	.00000
.0544	.54983-02	.75145-03	.00000	.15277-02	.11018+04	.25392+04	.94665+04	.11431+05	.00000	.00000
.0726	.55261-02	.73189-03	.00000	.15327-02	.13893+04	.28123+04	.98442+04	.11824+05	.00000	.00000
.0726	.55261-02	.73189-03	.00000	.15327-02	.13893+04	.28123+04	.98442+04	.11824+05	.00000	.00000
.0907	.55539-02	.71233-03	.00000	.15370-02	.16539+04	.30613+04	.10227+05	.12222+05	.00000	.00000
.0907	.55539-02	.71233-03	.00000	.15370-02	.16539+04	.30613+04	.10227+05	.12222+05	.00000	.00000
.1089	.55818-02	.69279-03	.00000	.15409-02	.18945+04	.32849+04	.10615+05	.12627+05	.00000	.00000
.1089	.55818-02	.69279-03	.00000	.15409-02	.18945+04	.32849+04	.10615+05	.12627+05	.00000	.00000
.1270	.56098-02	.67325-03	.00000	.15444-02	.21095+04	.34813+04	.11012+05	.13042+05	.00000	.00000
.1270	.56098-02	.67325-03	.00000	.15444-02	.21095+04	.34813+04	.11012+05	.13042+05	.00000	.00000
MAIN SHELL PART NO 8										
.0000	.14522-02	.54603-02	.00000	.15444-02	.14070+05	.20872+05	.40381+04	.76980+04	.00000	.00000
.0505	.15190-02	.55172-02	.00000	.11009-02	.12455+05	.19713+05	.77384+03	.11270+05	.00000	.00000
.1010	.15637-02	.55710-02	.00000	.67812-03	.99010+04	.17599+05	.48613+04	.13602+05	.00000	.00000
.1010	.15637-02	.55710-02	.00000	.67809-03	.99020+04	.17600+05	.48613+04	.13603+05	.00000	.00000
.1515	.15882-02	.56223-02	.00000	.30247-03	.67759+04	.14928+05	.81533+04	.14870+05	.00000	.00000
.2020	.15954-02	.56715-02	.00000	.47156-05	.33935+04	.12050+05	.10661+05	.15291+05	.00000	.00000
.2020	.15954-02	.56715-02	.00000	.46124-05	.33923+04	.12048+05	.10667+05	.15291+05	.00000	.00000
.2525	.15892-02	.57191-02	.00000	.22717-03	.31250-01	.92493+04	.12476+05	.15118+05	.00000	.00000
.3030	.15741-02	.57654-02	.00000	.35316-03	.32439+04	.67361+04	.13760+05	.14618+05	.00000	.00000
.3030	.15741-02	.57654-02	.00000	.35308-03	.32458+04	.67344+04	.13760+05	.14617+05	.00000	.00000
.3535	.15553-02	.58107-02	.00000	.37231-03	.62929+04	.46155+04	.14751+05	.14067+05	.00000	.00000
.4040	.15385-02	.58552-02	.00000	.27217-03	.92162+04	.29001+04	.15767+05	.13754+05	.00000	.00000
.4040	.15385-02	.58552-02	.00000	.27223-03	.92157+04	.29006+04	.15767+05	.13754+05	.00000	.00000
.4545	.15302-02	.58991-02	.00000	.29303-04	.12235+05	.14922+04	.17230+05	.13996+05	.00000	.00000
.5050	.15367-02	.59425-02	.00000	.40596-03	.15719+05	.22596+03	.19719+05	.15204+05	.00000	.00000
.5050	.15368-02	.59425-02	.00000	.40555-03	.15716+05	.22880+03	.19719+05	.15206+05	.00000	.00000
.5555	.15761-02	.59851-02	.00000	.11343-02	.20101+05	.95451+03	.24059+05	.18051+05	.00000	.00000
.6060	.16612-02	.60272-02	.00000	.23351-02	.25367+05	.12341+04	.31371+05	.23893+05	.00000	.00000
.6060	.16612-02	.60272-02	.00000	.23332-02	.25358+05	.12251+04	.31367+05	.23894+05	.00000	.00000
.6565	.18220-02	.60688-02	.00000	.40937-02	.27957+05	.50223+04	.42289+05	.36050+05	.00000	.00000
.7070	.20480-02	.61127-02	.00000	.34990-02	.23959+04	.55627+05	.47504+05	.65249+05	.00000	.00000

MAIN SHELL PART NO 9

.0000	.11710-02	.63392-02	.00000	.35056-02	.21972+04	.55653+05	.47680+05	.65035+05	.00000	.00000
.2030	.10553-02	.65216-02	.00000	.44944-03	.28032+05	.25423+05	.53965+05	.53182+05	.00000	.00000
.2030	.10589-02	.65215-02	.00000	.43669-03	.27736+05	.25719+05	.54084+05	.53479+05	.00000	.00000
.4060	.99190-03	.66837-02	.00000	.33954-03	.26942+05	.26514+05	.53857+05	.53729+05	.00000	.00000
.4060	.99491-03	.66836-02	.00000	.32895-03	.26695+05	.26760+05	.53957+05	.53976+05	.00000	.00000
.6090	.92814-03	.68191-02	.00000	.32804-03	.26684+05	.26771+05	.53981+05	.54007+05	.00000	.00000
.6090	.92762-03	.68191-02	.00000	.33053-03	.26723+05	.26733+05	.53962+05	.53965+05	.00000	.00000
.8120	.85776-03	.69284-02	.00000	.33899-03	.26942+05	.26514+05	.53877+05	.53749+05	.00000	.00000
.8120	.86032-03	.69283-02	.00000	.33100-03	.26726+05	.26730+05	.53960+05	.53961+05	.00000	.00000
1.0150	.79205-03	.70111-02	.00000	.33309-03	.26820+05	.26636+05	.53929+05	.53873+05	.00000	.00000
1.0150	.79313-03	.70111-02	.00000	.33064-03	.26723+05	.26733+05	.53962+05	.53965+05	.00000	.00000
1.2180	.72371-03	.70676-02	.00000	.33737-03	.26908+05	.26548+05	.53892+05	.53784+05	.00000	.00000
1.2180	.72582-03	.70676-02	.00000	.33109-03	.26727+05	.26729+05	.53959+05	.53960+05	.00000	.00000
1.4210	.65794-03	.70977-02	.00000	.33255-03	.26785+05	.26671+05	.53939+05	.53905+05	.00000	.00000
1.4210	.65864-03	.70977-02	.00000	.33070-03	.26723+05	.26732+05	.53961+05	.53964+05	.00000	.00000
1.6240	.58945-03	.71015-02	.00000	.33664-03	.26888+05	.26567+05	.53899+05	.53803+05	.00000	.00000
1.6240	.59142-03	.71015-02	.00000	.33054-03	.26722+05	.26733+05	.53962+05	.53966+05	.00000	.00000
1.8270	.52162-03	.70789-02	.00000	.33867-03	.26937+05	.26518+05	.53880+05	.53754+05	.00000	.00000
1.8270	.52413-03	.70789-02	.00000	.33091-03	.26725+05	.26730+05	.53960+05	.53962+05	.00000	.00000
2.0300	.45558-03	.70300-02	.00000	.33457-03	.26838+05	.26617+05	.53919+05	.53853+05	.00000	.00000
2.0300	.45690-03	.70299-02	.00000	.33081-03	.26724+05	.26731+05	.53961+05	.53963+05	.00000	.00000
2.2330	.38803-03	.69547-02	.00000	.33543-03	.26865+05	.26591+05	.53909+05	.53827+05	.00000	.00000
2.2330	.38963-03	.69546-02	.00000	.33102-03	.26726+05	.26730+05	.53960+05	.53961+05	.00000	.00000
2.4360	.32150-03	.68530-02	.00000	.33297-03	.26807+05	.26649+05	.53932+05	.53885+05	.00000	.00000
2.4360	.32240-03	.68530-02	.00000	.33096-03	.26725+05	.26730+05	.53960+05	.53962+05	.00000	.00000
2.6390	.25405-03	.67250-02	.00000	.33355-03	.26825+05	.26631+05	.53926+05	.53868+05	.00000	.00000
2.6390	.25513-03	.67250-02	.00000	.33117-03	.26727+05	.26729+05	.53959+05	.53959+05	.00000	.00000
2.8420	.18751-03	.65707-02	.00000	.33126-03	.26766+05	.26690+05	.53949+05	.53926+05	.00000	.00000
2.8420	.18790-03	.65707-02	.00000	.33114-03	.26727+05	.26729+05	.53959+05	.53960+05	.00000	.00000
3.0450	.12019-03	.63900-02	.00000	.33140-03	.26774+05	.26682+05	.53946+05	.53919+05	.00000	.00000
3.0450	.12063-03	.63900-02	.00000	.33130-03	.26728+05	.26728+05	.53958+05	.53958+05	.00000	.00000
3.2480	.53489-04	.61829-02	.00000	.32966-03	.26728+05	.26727+05	.53964+05	.53963+05	.00000	.00000
3.2480	.53393-04	.61829-02	.00000	.33131-03	.26728+05	.26728+05	.53958+05	.53958+05	.00000	.00000
3.4510	.13728-04	.59495-02	.00000	.32937-03	.26728+05	.26728+05	.53965+05	.53965+05	.00000	.00000
3.4510	.13865-04	.59495-02	.00000	.33143-03	.26729+05	.26727+05	.53957+05	.53957+05	.00000	.00000
3.6540	.80542-04	.56898-02	.00000	.32822-03	.26690+05	.26765+05	.53978+05	.54001+05	.00000	.00000
3.6540	.81110-04	.56898-02	.00000	.33147-03	.26729+05	.26727+05	.53957+05	.53957+05	.00000	.00000
3.8570	.14765-03	.54037-02	.00000	.32761-03	.26681+05	.26775+05	.53983+05	.54011+05	.00000	.00000

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3.8570	=.14836+03	.54837-02	.00000	.33155+03	.26729+05	.26726+05	.53957+05	.53956+05	.00000	.00000
4.0600	=.21466+03	.50912-02	.00000	.32649+03	.26664+05	.26792+05	.53991+05	.54029+05	.00000	.00000
4.0600	=.21561+03	.50912-02	.00000	.33161+03	.26730+05	.26726+05	.53956+05	.53955+05	.00000	.00000
4.2630	=.28167+03	.47524-02	.00000	.32576+03	.26644+05	.26811+05	.53999+05	.54049+05	.00000	.00000
4.2630	=.28285+03	.47524-02	.00000	.33165+03	.26730+05	.26726+05	.53956+05	.53955+05	.00000	.00000
4.4660	=.34878+03	.43873-02	.00000	.32509+03	.26635+05	.26820+05	.54003+05	.54059+05	.00000	.00000
4.4660	=.35009+03	.43873-02	.00000	.33126+03	.26732+05	.26723+05	.53957+05	.53954+05	.00000	.00000
4.6690	=.41622+03	.39957-02	.00000	.33686+03	.26581+05	.26875+05	.53975+05	.54064+05	.00000	.00000
4.6690	=.41807+03	.39958-02	.00000	.34548+03	.26718+05	.26738+05	.53910+05	.53916+05	.00000	.00000
4.8720	=.46292+03	.35775-02	.00000	.31980+05	.26606+05	.26850+05	.55165+05	.55238+05	.00000	.00000
4.8720	=.46519+03	.35776-02	.00000	.83596+05	.26777+05	.26679+05	.55085+05	.55056+05	.00000	.00000
5.0750	=.10759+02	.31444-02	.00000	.76382-02	.34663+05	.18793+05	.26185+05	.21824+05	.00000	.00000
MAIN SHELL PART NO 10										
.0000	=.10781-02	.31445-02	.00000	.76481-02	.38198+05	.61248+04	.27118+05	.13821+05	.00000	.00000
.0313	=.12796-02	.30854-02	.00000	.51362-02	.45180+05	.13106+05	.17622+05	.13633+03	.00000	.00000
.0313	=.12796-02	.30854-02	.00000	.51362-02	.45180+05	.13106+05	.17622+05	.13632+03	.00000	.00000
.0625	=.13954+02	.30307+02	.00000	.22502-02	.46905+05	.14831+05	.11476+05	.70446+04	.00000	.00000
.0625	=.13954+02	.30307+02	.00000	.22502-02	.46905+05	.14831+05	.11476+05	.70446+04	.00000	.00000
.0938	=.14195-02	.29775-02	.00000	.71079-03	.47128+05	.15054+05	.10156+05	.84989+04	.00000	.00000
.0938	=.14195-02	.29775-02	.00000	.71057-03	.47126+05	.15053+05	.10156+05	.84980+04	.00000	.00000
.1250	=.13511+02	.29239+02	.00000	.36639+02	.46626+05	.14553+05	.13945+05	.44091+04	.00000	.00000
MAIN SHELL PART NO 11										
.0000	.29239+02	.13511+02	.00000	.36637+02	.16794+03	.20498+03	.16433+05	.16335+05	.00000	.00000
.0288	.30303+02	.12760-02	.00000	.37219-02	.10858+04	.10524+04	.18056+05	.17954+05	.00000	.00000
.0288	.30303+02	.12760-02	.00000	.37219-02	.10858+04	.10524+04	.18056+05	.17954+05	.00000	.00000
.0576	.31382+02	.12009+02	.00000	.37720+02	.21210+04	.20929+04	.19729+05	.19623+05	.00000	.00000
.0576	.31382+02	.12009+02	.00000	.37720+02	.21210+04	.20929+04	.19729+05	.19623+05	.00000	.00000
.0864	.32475+02	.11259+02	.00000	.38171-02	.29093+04	.28857+04	.21482+05	.21371+05	.00000	.00000
.0864	.32475+02	.11259+02	.00000	.38171-02	.29093+04	.28857+04	.21482+05	.21371+05	.00000	.00000
.1152	.33581+02	.10508+02	.00000	.38608-02	.34061+04	.33890+04	.23358+05	.23240+05	.00000	.00000
.1152	.33581+02	.10508+02	.00000	.38608-02	.34061+04	.33890+04	.23358+05	.23240+05	.00000	.00000
.1440	.34699+02	.97572+03	.00000	.39078-02	.35531+04	.35441+04	.25414+05	.25288+05	.00000	.00000
.1440	.34699+02	.97572+03	.00000	.39078-02	.35531+04	.35441+04	.25414+05	.25288+05	.00000	.00000
.1728	.35833+02	.90666+03	.00000	.39635-02	.32657+04	.32669+04	.27736+05	.27600+05	.00000	.00000
.1728	.35833+02	.90666+03	.00000	.39635-02	.32657+04	.32669+04	.27736+05	.27600+05	.00000	.00000
.2016	.36984+02	.82561+03	.00000	.40353-02	.24193+04	.24336+04	.30447+05	.30298+05	.00000	.00000
.2016	.36984+02	.82561+03	.00000	.40353-02	.24193+04	.24336+04	.30447+05	.30298+05	.00000	.00000
.2304	.38159+02	.75057+03	.00000	.41329+02	.82352+03	.85501+03	.33738+05	.33971+05	.00000	.00000
.2304	.38159+02	.75057+03	.00000	.41329+02	.82352+03	.85501+03	.33738+05	.33971+05	.00000	.00000
MAIN SHELL PART NO 12										



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Mount Bracket Form, Rev. 8

.0000	-.75057-03	.30159-02	.00000	-.41329-02	-.25706+05	.39652+05	-.77999+04	.11807+05	.00000	.00000
.0275	-.66640-03	.37488-02	.00000	-.20281-02	-.22229+05	.36174+05	.19644+04	.19485+05	.00000	.00000
.0275	-.66640-03	.37488-02	.00000	-.20281-02	-.22229+05	.36174+05	.19644+04	.19485+05	.00000	.00000
.0550	-.63581-03	.36800-02	.00000	-.26493-03	-.16151+05	.36096+05	.69573+04	.20831+05	.00000	.00000
.0550	-.63581-03	.36800-02	.00000	-.26494-03	-.16151+05	.36096+05	.69573+04	.20831+05	.00000	.00000
.0825	-.64788-03	.36110-02	.00000	.10688-02	-.95335+04	.23479+05	.76918+04	.17595+05	.00000	.00000
.0825	-.64788-03	.36110-02	.00000	.10689-02	-.95335+04	.23480+05	.76914+04	.17596+05	.00000	.00000
.1100	-.69027-03	.35428-02	.00000	.19263-02	-.16592+04	.15605+05	.56618+04	.10841+05	.00000	.00000
.1100	-.69027-03	.35428-02	.00000	.19263-02	-.16592+04	.15605+05	.56618+04	.10841+05	.00000	.00000
.1375	-.74801-03	.34761-02	.00000	.21409-02	-.10169+05	.37768+04	.32277+04	.13102+04	.00000	.00000
.1375	-.74801-03	.34761-02	.00000	.21409-02	-.10169+05	.37768+04	.32277+04	.13102+04	.00000	.00000
.1650	-.79867-03	.34110-02	.00000	.13263-02	.29603+05	-.15657+05	.38084+04	-.97695+04	.00000	.00000
.1650	-.79867-03	.34110-02	.00000	.13264-02	.29600+05	-.15655+05	.38080+04	-.97686+04	.00000	.00000
.1925	-.80585-03	.33468-02	.00000	-.11416-02	.59757+05	-.45811+05	.12111+05	-.19560+05	.00000	.00000
.1925	-.80585-03	.33468-02	.00000	-.11416-02	.59756+05	-.45810+05	.12110+05	-.19559+05	.00000	.00000
.2200	-.71378-03	.32816-02	.00000	-.60150-02	.10081+06	-.86860+05	.33965+05	-.22334+05	.00000	.00000
MAIN SHELL PART NO 13										
.0000	.32816-02	.71379-03	.00000	-.60144-02	.52754+05	-.42988+05	.86431+04	.17322+04	.00000	.00000
.0475	.36500-02	.59516-03	.00000	-.91131-02	.22527+05	-.12894+05	-.92284+04	.19736+05	.00000	.00000
.0475	.36500-02	.59516-03	.00000	-.91131-02	.22527+05	-.12894+05	-.92284+04	.19736+05	.00000	.00000
.0950	.41358-02	.47634-03	.00000	-.10201-01	-.13504+04	.10742+05	-.24064+05	.34815+05	.00000	.00000
.0950	.41358-02	.47634-03	.00000	-.10201-01	-.13494+04	.10741+05	-.24066+05	.34816+05	.00000	.00000
.1426	.45962-02	.35715-03	.00000	-.98190-02	-.18089+05	.26962+05	-.36428+05	-.47697+05	.00000	.00000
.1426	.45963-02	.35715-03	.00000	-.98203-02	-.18087+05	.26960+05	-.36432+05	-.47701+05	.00000	.00000
.1901	.50373-02	.23705-03	.00000	-.87076-02	-.24755+05	.32176+05	-.48745+05	.61465+05	.00000	.00000
.1901	.50375-02	.23704-03	.00000	-.87114-02	-.24782+05	.32174+05	-.48762+05	.61485+05	.00000	.00000
.2376	.54384-02	.11345-03	.00000	-.87042-02	-.17372+02	-.34969+02	-.80711+05	.10084+06	.00000	.00000



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Aluminum Research Form 100-1

KALNINS SHELL STRESS ANALYSIS.....COLD END PRESSURE SHELL 4 JAN 74

SUBCASE NO 2 FOR FOURIER HARMONIC COS 0 THETA

BOUNDARY CONDITIONS AT STARTING EDGE	1=	.00000	3=	.00000	5=	.00000	7=	.00000
BOUNDARY CONDITIONS AT FINAL EDGE	2=	.00000	4=	.00000	6=	.00000	8=	.00000
BOUNDARY CONDITION AT BRANCH EDGE NO 1	2=	.00000	3=	.00000	6=	.00000	8=	.00000

LOADS FOR PART NO 1 SUBCASE NO 2

RING LOADS AT END OF THIS PART ARE	Q=	.00000	NPHI=	.00000	MPHI=	.00000	N=	.00000
	WK=	.00000	UK=	.00000	UTHK=	.00000		
SURFACE AND TEMP LOADS ARE	P=	.28000+04	PF1=	.00000	PTHETA=	.00000	TL=	.14000+03
							TU=	.14000+03

LOADS FOR PART NO 2 SUBCASE NO 2

RING LOADS AT END OF THIS PART ARE	Q=	.00000	NPHI=	.00000	MPHI=	.00000	N=	.00000
	WK=	.00000	UK=	.00000	UTHK=	.00000		
SURFACE AND TEMP LOADS ARE	P=	.00000	PF1=	.00000	PTHETA=	.00000	TL=	.14000+03
							TU=	.14000+03

LOADS FOR PART NO 3 SUBCASE NO 2

RING LOADS AT END OF THIS PART ARE	Q=	.00000	NPHI=	.00000	MPHI=	.00000	N=	.00000
	WK=	.00000	UK=	.00000	UTHK=	.00000		
SURFACE AND TEMP LOADS ARE	P=	.28000+04	PF1=	.00000	PTHETA=	.00000	TL=	.14000+03
							TU=	.14000+03

LOADS FOR PART NO 4 SUBCASE NO 2

RING LOADS AT END OF THIS PART ARE	Q=	.00000	NPHI=	.00000	MPHI=	.00000	N=	.00000
	WK=	.00000	UK=	.00000	UTHK=	.00000		
SURFACE AND TEMP LOADS ARE	P=	.28000+04	PF1=	.00000	PTHETA=	.00000	TL=	.14000+03
							TU=	.14000+03

LOADS FOR PART NO 5 SUBCASE NO 2

RING LOADS AT END OF THIS PART ARE	Q=	.00000	NPHI=	.00000	MPHI=	.00000	N=	.00000
	WK=	.00000	UK=	.00000	UTHK=	.00000		
SURFACE AND TEMP LOADS ARE	P=	.28000+04	PF1=	.00000	PTHETA=	.00000	TL=	.14000+03
							TU=	.14000+03

LOADS FOR PART NO 6 SUBCASE NO 2

RING LOADS AT END OF THIS PART ARE	Q=	.00000	NPHI=	.00000	MPHI=	.00000	N=	.00000
	WK=	.00000	UK=	.00000	UTHK=	.00000		
SURFACE AND TEMP LOADS ARE	P=	.28000+04	PF1=	.00000	PTHETA=	.00000	TL=	.14000+03
							TU=	.14000+03

LOADS FOR PART NO 7 SUBCASE NO 2

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RING LOADS AT END OF THIS PART ARE $Q = .00000$ $NPHI = .00000$ $MPHI = .00000$ $N = .00000$
 $WK = .00000$ $UK = .00000$ $UTHK = .00000$

SURFACE AND TEMP LOADS ARE $P = .28000+04$ $PFI = .00000$ $PTHETA = .00000$ $TL = .14000+03$ $TU = .14000+03$

LOADS FOR PART NO 8 SUBCASE NO 2

RING LOADS AT END OF THIS PART ARE $Q = .00000$ $NPHI = .00000$ $MPHI = .00000$ $N = .00000$
 $WK = .00000$ $UK = .00000$ $UTHK = .00000$

SURFACE AND TEMP LOADS ARE $P = .28000+04$ $PFI = .00000$ $PTHETA = .00000$ $TL = .14000+03$ $TU = .84000+02$

CODE NUMBERS OF VARIABLE LOADS OVER THIS PART, GIVEN BY FGENS BELOW, ARE 4 5

TI LINEAR FUNCTION GENERATOR NO. 3 FROM 2 POINTS

Y COORDINATES .1400+03 .8400+02

X COORDINATES .0000 .7070+00

TD LINEAR FUNCTION GENERATOR NO. 4 FROM 2 POINTS

Y COORDINATES .1400+03 .8400+02

X COORDINATES .0000 .7070+00

LOADS FOR PART NO 9 SUBCASE NO 2

RING LOADS AT END OF THIS PART ARE $Q = .00000$ $NPHI = .00000$ $MPHI = .00000$ $N = .00000$
 $WK = .00000$ $UK = .00000$ $UTHK = .00000$

SURFACE AND TEMP LOADS ARE $P = .28000+04$ $PFI = .00000$ $PTHETA = .00000$ $TL = .84000+02$ $TU = .34300+03$

CODE NUMBERS OF VARIABLE LOADS OVER THIS PART, GIVEN BY FGENS BELOW, ARE 4 5

TL LINEAR FUNCTION GENERATOR NO. 5 FROM 2 POINTS

Y COORDINATES .8400+02 .3430+03

X COORDINATES .0000 .5075+01

TU LINEAR FUNCTION GENERATOR NO. 6 FROM 2 POINTS

Y COORDINATES .8400+02 .3430+03

X COORDINATES .0000 .5075+01

LOADS FOR PART NO 10 SUBCASE NO 2

RING LOADS AT END OF THIS PART ARE $Q = .00000$ $NPHI = .00000$ $MPHI = .00000$ $N = .00000$
 $WK = .00000$ $UK = .00000$ $UTHK = .00000$

SURFACE AND TEMP LOADS ARE $P = .00000$ $PFI = .00000$ $PTHETA = .00000$ $TL = .34300+03$ $TU = .34300+03$

LOADS FOR PART NO 11 SUBCASE NO 2

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RING LOADS AT END OF THIS PART ARE Q= .00000 NPHI= .00000 MPHI= .00000 N= .00000
WK= .00000 UK= .00000 UTHK= .00000

SURFACE AND TEMP LOADS ARE P= .28000+04 PFI= .00000 PTHETA= .00000 TL= .34300+03 TU= .34300+03

LOADS FOR PART NO 12 SUBCASE NO 2

RING LOADS AT END OF THIS PART ARE Q= .00000 NPHI= .00000 MPHI= .00000 N= .00000
WK= .00000 UK= .00000 UTHK= .00000

SURFACE AND TEMP LOADS ARE P= .28000+04 PFI= .00000 PTHETA= .00000 TL= .34300+03 TU= .34300+03

LOADS FOR PART NO 13 SUBCASE NO 2

RING LOADS AT END OF THIS PART ARE Q= .00000 NPHI= .00000 MPHI= .00000 N= .00000
WK= .00000 UK= .00000 UTHK= .00000

SURFACE AND TEMP LOADS ARE P= .28000+04 PFI= .00000 PTHETA= .00000 TL= .34300+03 TU= .34300+03

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AIRSEARCH MANUFACTURING COMPANY
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KALVINS SHELL STRESS ANALYSIS.....COLD END PRESSURE SHELL

4 JAN 74

DEFLECTIONS AND STRESS RESULTANTS FOR WAVE NUMBER NX= 0 BURST PRESSURE OF 2800 PSI PLUS TEMPERATURE LOADING

X	W	Q	UPHI	NPHI	BPHI	MPHI	UTHETA	N	NTHETA	MTHETA
MAIN SHELL PART NO 1										
.0000	.00000	.12994+04	.00000	.80032+03	.00000	-.11498+03	.00000	.00000	-.26136+04	-.34494+02
.2500	.65251+03	.48881+02	.37607+03	.80032+03	-.24566+02	.23249+02	.00000	.00000	.42469+03	.69746+01
.2500	.65246+03	.48845+02	.37608+03	.80032+03	-.24561+02	.23252+02	.00000	.00000	.42449+03	.69756+01
.5000	.94098+03	-.79267+02	.67983+03	.80032+03	-.22550+03	.77150+01	.00000	.00000	.17679+04	.23145+01
.5000	.94093+03	-.79228+02	.67983+03	.80032+03	-.22495+03	.77268+01	.00000	.00000	.17677+04	.23180+01
.7500	.95370+03	.51544+01	.96989+03	.80032+03	-.78896+04	-.18575+01	.00000	.00000	.16271+04	-.55726+00
.7500	.95369+03	.51752+01	.96989+03	.80032+03	-.78745+04	-.18541+01	.00000	.00000	.16271+04	-.55622+00
1.0000	.96184+03	.12081+03	.12579+02	.80032+03	.32599+03	.13224+02	.00000	.00000	.18650+04	.39673+01
1.0000	.96182+03	.12084+03	.12579+02	.80032+03	.32629+03	.13230+02	.00000	.00000	.18649+04	.39691+01
1.2500	.50156+03	-.79504+02	.15663+02	.80032+03	.39336+02	.37135+02	.00000	.00000	.27816+03	.11141+02
1.2500	.50155+03	-.79481+02	.15663+02	.80032+03	.39338+02	.37140+02	.00000	.00000	.27821+03	.11142+02
1.5000	-.54214+03	-.20759+04	.19905+02	.80032+03	-.69925+06	-.18379+03	.00000	.00000	.51379+04	.55136+02
BRANCH SHELL PART NO 2										
.0000	-.19905+02	-.78237+04	-.54218+03	-.41522+04	-.97748+06	.70343+01	.00000	.00000	-.14173+05	-.92682+01
.1623	-.19903+02	-.61035+04	-.37939+03	-.70917+04	-.79628+06	.38430+01	.00000	.00000	-.16233+05	-.60783+01
.1623	-.19903+02	-.61035+04	-.37939+03	-.70917+04	-.79742+06	.38360+01	.00000	.00000	-.16233+05	-.60902+01
.3247	-.19902+02	-.50034+04	-.26646+03	-.85999+04	-.66845+06	.22089+01	.00000	.00000	-.14734+05	-.44625+01
.3247	-.19902+02	-.66665+04	-.26646+03	-.85999+04	-.66854+06	.22087+01	.00000	.00000	-.14734+05	-.44632+01
.4870	-.19901+02	-.56179+04	-.18054+03	-.94575+04	-.61870+06	.12666+01	.00000	.00000	-.13868+05	-.35225+01
.4870	-.19901+02	-.38147+04	-.18098+03	-.94575+04	-.61877+06	.12669+01	.00000	.00000	-.13868+05	-.35229+01
.6493	-.19900+02	-.33093+04	-.11090+03	-.10003+05	-.57250+06	.67379+02	.00000	.00000	-.13322+05	-.29306+01
.6493	-.19900+02	-.22886+04	-.11090+03	-.10003+05	-.57250+06	.67406+02	.00000	.00000	-.13322+05	-.29305+01
.8117	-.19899+02	-.20211+04	-.51829+04	-.10369+05	-.54154+06	.27671+02	.00000	.00000	-.12957+05	-.25336+01
.8117	-.19899+02	-.20981+04	-.51829+04	-.10369+05	-.54145+06	.27767+02	.00000	.00000	-.12957+05	-.25329+01
.9740	-.19898+02	-.18783+04	.11710+10	-.10625+05	-.52097+06	-.15834+04	.00000	.00000	-.12700+05	-.22541+01
MAIN SHELL PART NO 3										
.0000	-.54218+03	.20762+04	.19905+02	.80032+03	-.97748+06	-.18387+03	.00000	.00000	-.51381+04	-.55162+02
.1500	.30354+04	.58985+03	.22635+02	.80032+03	-.52594+02	-.68675+01	.00000	.00000	-.24722+04	-.20603+01
.1500	.30351+04	.58985+03	.22635+02	.80032+03	-.52594+02	-.68691+01	.00000	.00000	-.24722+04	-.20607+01
.3000	.67588+03	-.46353+02	.24818+02	.80032+03	-.29838+02	-.37769+02	.00000	.00000	-.53351+03	-.11331+02
.3000	.67586+03	-.46342+02	.24818+02	.80032+03	-.29838+02	.37768+02	.00000	.00000	.53342+03	.11331+02
.4500	.93634+03	-.13496+03	.26648+02	.80032+03	-.71844+03	.20275+02	.00000	.00000	.17463+04	.60825+01
.4500	.93633+03	-.13495+03	.26648+02	.80032+03	-.71854+03	.20276+02	.00000	.00000	.17462+04	.60829+01
.6000	.96386+03	-.70508+02	.28380+02	.80032+03	-.15217+03	.44944+01	.00000	.00000	.18744+04	-.13483+01
.6000	.96387+03	-.70520+02	.28380+02	.80032+03	.15212+03	.44930+01	.00000	.00000	.18745+04	.13479+01

KALVINS SHELL STRESS ANALYSIS

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.7500	.93125+03	.21503+02	.30121+02	.80032+03	.20367+03	.18983+01	.00000	.00000	.17226+04	.56950+00
.7500	.93126+03	.21512+02	.30121+02	.80032+03	.20368+03	.18975+01	.00000	.00000	.17226+04	.56924+00
.9000	.91395+03	.56591+01	.31884+02	.80032+03	.21570+04	.36981+01	.00000	.00000	.16513+04	.11094+01
.9000	.91595+03	.56617+01	.31884+02	.80032+03	.21589+04	.36988+01	.00000	.00000	.16513+04	.11096+01
1.0500	.94082+03	.15069+02	.33644+02	.80032+03	.30683+03	.33708+01	.00000	.00000	.17671+04	.10112+01
1.0500	.94082+03	.15066+02	.33644+02	.80032+03	.30683+03	.33711+01	.00000	.00000	.17671+04	.10113+01
1.2000	.99792+03	.88709+02	.35369+02	.80032+03	.37011+03	.35276+01	.00000	.00000	.20330+04	.10583+01
1.2000	.99792+03	.88704+02	.35369+02	.80032+03	.37012+03	.35271+01	.00000	.00000	.20330+04	.10581+01
1.3500	.99991+03	.21410+03	.37062+02	.80032+03	.62751+03	.26143+02	.00000	.00000	.20423+04	.78428+01
1.3500	.99991+03	.21409+03	.37062+02	.80032+03	.62750+03	.26142+02	.00000	.00000	.20423+04	.78427+01
1.5000	.69203+03	.18932+03	.38851+02	.80032+03	.39261+02	.60970+02	.00000	.00000	.60873+03	.18291+02

MAIN SHELL PART NO 4

.0000	.38851+02	.80032+03	.69212+03	.18934+03	.39253+02	.60962+02	.00000	.00000	.12869+04	.47522+03
.0437	.40553+02	.86188+03	.73786+03	.26396+03	.38741+02	.53697+02	.00000	.00000	.12123+04	.43530+03
.0873	.42234+02	.92339+03	.78404+03	.32433+03	.38235+02	.39881+02	.00000	.00000	.11519+04	.39845+03
.0873	.42234+02	.92339+03	.78404+03	.32433+03	.38235+02	.39881+02	.00000	.00000	.11519+04	.39845+03
.1310	.43892+02	.98485+03	.83056+03	.37386+03	.37690+02	.20552+02	.00000	.00000	.11024+04	.36361+03
.1747	.45525+02	.10463+04	.87736+03	.41501+03	.37071+02	.35417+01	.00000	.00000	.10612+04	.33006+03
.1747	.45525+02	.10463+04	.87736+03	.41501+03	.37071+02	.35415+01	.00000	.00000	.10612+04	.33006+03
.2183	.47128+02	.11077+04	.92441+03	.44956+03	.36345+02	.31854+02	.00000	.00000	.10267+04	.29723+03
.2620	.48697+02	.11690+04	.97168+03	.47885+03	.35486+02	.63978+02	.00000	.00000	.99739+03	.26474+03
.2620	.48697+02	.11690+04	.97168+03	.47885+03	.35486+02	.63978+02	.00000	.00000	.99739+03	.26474+03
.3057	.50225+02	.12304+04	.10191+02	.50369+03	.34470+02	.99602+02	.00000	.00000	.97235+03	.23226+03
.3493	.51704+02	.12917+04	.10666+02	.52548+03	.33274+02	.13849+03	.00000	.00000	.95076+03	.19956+03
.3493	.51704+02	.12917+04	.10666+02	.52548+03	.33274+02	.13849+03	.00000	.00000	.95076+03	.19956+03
.3930	.53128+02	.13530+04	.11143+02	.54421+03	.31880+02	.18045+03	.00000	.00000	.93203+03	.16646+03
.4367	.54485+02	.14143+04	.11621+02	.56057+03	.30267+02	.22534+03	.00000	.00000	.91567+03	.13280+03
.4367	.54485+02	.14143+04	.11621+02	.56057+03	.30267+02	.22534+03	.00000	.00000	.91567+03	.13280+03
.4803	.55768+02	.14756+04	.12101+02	.57495+03	.28420+02	.27304+03	.00000	.00000	.90129+03	.98482+02
.5240	.56964+02	.15368+04	.12580+02	.58765+03	.26321+02	.32346+03	.00000	.00000	.88859+03	.63399+02

MAIN SHELL PART NO 5

.0000	.12580+02	.58765+03	.56964+02	.15368+04	.26321+02	.32346+03	.00000	.00000	.93591+03	.97038+02
.1000	.10648+02	.33956+03	.58268+02	.15368+04	.12680+02	.27631+03	.00000	.00000	.11086+03	.82892+02
.1000	.10648+02	.33956+03	.58268+02	.15368+04	.12680+02	.27631+03	.00000	.00000	.11086+03	.82892+02
.2000	.99931+03	.28360+02	.59607+02	.15368+04	.56912+04	.25764+03	.00000	.00000	.46596+03	.77292+02
.2000	.99931+03	.28324+02	.59607+02	.15368+04	.56983+04	.25764+03	.00000	.00000	.46593+03	.77293+02
.3000	.10530+02	.28573+03	.60948+02	.15368+04	.11412+02	.27073+03	.00000	.00000	.17494+03	.81220+02
.3000	.10530+02	.28573+03	.60948+02	.15368+04	.11412+02	.27073+03	.00000	.00000	.17494+03	.81220+02
.4000	.10530+02	.28576+03	.60948+02	.15368+04	.11411+02	.27073+03	.00000	.00000	.17495+03	.81220+02
.4000	.12319+02	.54308+03	.62257+02	.15368+04	.24680+02	.31291+03	.00000	.00000	.79409+03	.93873+02

MAIN SHELL PART NO 6

.0000	.62257+02	.15368+04	.12319+02	.54311+03	.24680+02	.31291+03	.00000	.00000	.66242+03	.56561+02
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More Models From, Inc.

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More Models From, Inc.

.1187	.65094+02	.13703+04	.11011+02	.52781+03	.29559+02	.18006+03	.00000	.00000	.67773+03	.14794+03
.1187	.65494+02	.13703+04	.11011+02	.52781+03	.29559+02	.18006+03	.00000	.00000	.67772+03	.14794+03
.2373	.69205+02	.12037+04	.97076+03	.50577+03	.32735+02	.67697+02	.00000	.00000	.69977+03	.23412+03
.2373	.69205+02	.12037+04	.97076+03	.50578+03	.32735+02	.67697+02	.00000	.00000	.69977+03	.23412+03
.3560	.73210+02	.10369+04	.84084+03	.47237+03	.34574+02	.21281+02	.00000	.00000	.73319+03	.31797+03
MAIN SHELL PART NO 7										
.0000	.73210+02	.10369+04	.84084+03	.47238+03	.34574+02	.21281+02	.00000	.00000	.73321+03	.31797+03
.0181	.73839+02	.10114+04	.82103+03	.46378+03	.34765+02	.32518+02	.00000	.00000	.73981+03	.33089+03
.0181	.73839+02	.10114+04	.82103+03	.46578+03	.34765+02	.32518+02	.00000	.00000	.73981+03	.33089+03
.0363	.74471+02	.98585+03	.80124+03	.45866+03	.34936+02	.43053+02	.00000	.00000	.74693+03	.34391+03
.0363	.74471+02	.98585+03	.80124+03	.45866+03	.34936+02	.43053+02	.00000	.00000	.74692+03	.34391+03
.0544	.75107+02	.96032+03	.78147+03	.45098+03	.35091+02	.52853+02	.00000	.00000	.75461+03	.35706+03
.0544	.75107+02	.96032+03	.78147+03	.45098+03	.35091+02	.52853+02	.00000	.00000	.75461+03	.35706+03
.0726	.75745+02	.93479+03	.76172+03	.44266+03	.35231+02	.61878+02	.00000	.00000	.76292+03	.37038+03
.0726	.75745+02	.93479+03	.76172+03	.44266+03	.35231+02	.61878+02	.00000	.00000	.76292+03	.37038+03
.0907	.76385+02	.90924+03	.74199+03	.43364+03	.35358+02	.70084+02	.00000	.00000	.77194+03	.38392+03
.0907	.76385+02	.90924+03	.74199+03	.43364+03	.35358+02	.70084+02	.00000	.00000	.77194+03	.38392+03
.1089	.77027+02	.88369+03	.72229+03	.42384+03	.35475+02	.77420+02	.00000	.00000	.78174+03	.39773+03
.1089	.77027+02	.88369+03	.72229+03	.42384+03	.35475+02	.77420+02	.00000	.00000	.78174+03	.39773+03
.1270	.77672+02	.85813+03	.70262+03	.41316+03	.35586+02	.83829+02	.00000	.00000	.79242+03	.41186+03
.1270	.77672+02	.85813+03	.70262+03	.41316+03	.35586+02	.83829+02	.00000	.00000	.79242+03	.41186+03
MAIN SHELL PART NO 8										
.0000	.17834+02	.28893+03	.75923+02	.90753+03	.35586+02	.83829+02	.00000	.00000	.53966+03	.28615+02
.0505	.19406+02	.34946+03	.76539+02	.90602+03	.26709+02	.67972+02	.00000	.00000	.14748+04	.22547+02
.1010	.20538+02	.34652+03	.77110+02	.89554+03	.18201+02	.50649+02	.00000	.00000	.20723+04	.16395+02
.1010	.20538+02	.34650+03	.77110+02	.89554+03	.18200+02	.50652+02	.00000	.00000	.20724+04	.16396+02
.1515	.21260+02	.30396+03	.77645+02	.87946+03	.10608+02	.34447+02	.00000	.00000	.23868+04	.10897+02
.2020	.21632+02	.24180+03	.78153+02	.86059+03	.43751+03	.20844+02	.00000	.00000	.24813+04	.64364+01
.2020	.21632+02	.24181+03	.78153+02	.86060+03	.43772+03	.20841+02	.00000	.00000	.24813+04	.64355+01
.2525	.21731+02	.17539+03	.78643+02	.84113+03	.14931+04	.10444+02	.00000	.00000	.24215+04	.31283+01
.3030	.21650+02	.11523+03	.79124+02	.82255+03	.27037+03	.32041+01	.00000	.00000	.22697+04	.89568+00
.3030	.21650+02	.11525+03	.79124+02	.82255+03	.27039+03	.32045+01	.00000	.00000	.22697+04	.89579+00
.3535	.21495+02	.67214+02	.79601+02	.80568+03	.54481+03	.13384+01	.00000	.00000	.20806+04	.45522+00
.4040	.21384+02	.33032+02	.80078+02	.79077+03	.87517+04	.38366+01	.00000	.00000	.18984+04	.11617+01
.4040	.21384+02	.33046+02	.80078+02	.79077+03	.87610+04	.38363+01	.00000	.00000	.18985+04	.11617+01
.4545	.21458+02	.11042+02	.80559+02	.77758+03	.43723+03	.49481+01	.00000	.00000	.17561+04	.14483+01
.5050	.21896+02	.29942+01	.81044+02	.76552+03	.13845+02	.51747+01	.00000	.00000	.16744+04	.14830+01
.5050	.21896+02	.29917+01	.81044+02	.76552+03	.13837+02	.51732+01	.00000	.00000	.16744+04	.14824+01
.5555	.22765+02	.14431+02	.81534+02	.75376+03	.29846+02	.47747+01	.00000	.00000	.16607+04	.13889+01
.6060	.25088+02	.30397+02	.82028+02	.74147+03	.56430+02	.37009+01	.00000	.00000	.17021+04	.10342+01
.6060	.25088+02	.30389+02	.82028+02	.74147+03	.56390+02	.36986+01	.00000	.00000	.17021+04	.10335+01
.6565	.28890+02	.52628+02	.82530+02	.72824+03	.95566+02	.16545+01	.00000	.00000	.17330+04	.44785+00
.7070	.34145+02	.71778+02	.83105+02	.71544+03	.82136+02	.15591+01	.00000	.00000	.15169+04	.47726+00

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MAIN SHELL PART NO 9

.0000	.22151-02	.79225-02	.87065-02	.71844+03	.82263-02	.15549+01	.00000	.00000	.15164+04	.46648-00
.2030	.20383-02	.69386-00	.89707-02	.71844+03	.59138-03	.67743-01	.00000	.00000	.14408+04	.20327-01
.2030	.20452-02	.11992+01	.89705-02	.71844+03	.56632-03	.54255-01	.00000	.00000	.14456+04	.16276-01
.4060	.19800-02	.44036-00	.92221-02	.71844+03	.34492-03	.87474-02	.00000	.00000	.14469+04	.26242-02
.4060	.19856-02	.31366-01	.92220-02	.71844+03	.32403-03	.21195-02	.00000	.00000	.14508+04	.63584-03
.6090	.19123-02	.39285-00	.94467-02	.71844+03	.34976-03	.10743-01	.00000	.00000	.14467+04	.32229-02
.6090	.19178-02	.61893-02	.94465-02	.71844+03	.33112-03	.77481-05	.00000	.00000	.14504+04	.23244-05
.8120	.18493-02	.96250-01	.96447-02	.71844+03	.33170-03	.29105-02	.00000	.00000	.14496+04	.87315-03
.8120	.18507-02	.13296-01	.96447-02	.71844+03	.32972-03	.28119-03	.00000	.00000	.14505+04	.84357-04
1.0150	.17782-02	.37257-00	.98167-02	.71844+03	.34835-03	.10110-01	.00000	.00000	.14469+04	.30329-02
1.0150	.17834-02	.13588-01	.98165-02	.71844+03	.32984-03	.24476-03	.00000	.00000	.14505+04	.73428-04
1.2180	.17111-02	.35906-00	.99622-02	.71844+03	.34728-03	.97763-02	.00000	.00000	.14470+04	.29329-02
1.2180	.17160-02	.21591-02	.99620-02	.71844+03	.33172-03	.82769-04	.00000	.00000	.14504+04	.24831-04
1.4210	.16500-02	.84538-01	.10081-01	.71844+03	.32452-03	.20783-02	.00000	.00000	.14513+04	.62349-03
1.4210	.16491-02	.21387-01	.10081-01	.71844+03	.32868-03	.47505-03	.00000	.00000	.14506+04	.14252-03
1.6240	.15732-02	.61194-00	.10174-01	.71844+03	.36014-03	.16545-01	.00000	.00000	.14446+04	.49634-02
1.6240	.15817-02	.12924-01	.10174-01	.71844+03	.33000-03	.19543-03	.00000	.00000	.14505+04	.58628-04
1.8270	.15099-02	.32278-00	.10241-01	.71844+03	.34589-03	.87688-02	.00000	.00000	.14474+04	.26306-02
1.8270	.15145-02	.13241-01	.10240-01	.71844+03	.32986-03	.24872-03	.00000	.00000	.14505+04	.74616-04
2.0300	.14422-02	.35411-00	.10281-01	.71844+03	.34668-03	.96708-02	.00000	.00000	.14471+04	.29012-02
2.0300	.14472-02	.13222-01	.10281-01	.71844+03	.32989-03	.24275-03	.00000	.00000	.14505+04	.72824-04
2.2330	.13751-02	.35008-00	.10294-01	.71844+03	.34618-03	.95856-02	.00000	.00000	.14471+04	.28757-02
2.2330	.13800-02	.15941-01	.10294-01	.71844+03	.32957-03	.29056-03	.00000	.00000	.14506+04	.87168-04
2.4360	.13069-02	.41577-00	.10282-01	.71844+03	.35029-03	.11284-01	.00000	.00000	.14465+04	.33852-02
2.4360	.13127-02	.10405-01	.10282-01	.71844+03	.33023-03	.17097-03	.00000	.00000	.14505+04	.51291-04
2.6390	.12417-02	.26568-00	.10243-01	.71844+03	.34268-03	.72659-02	.00000	.00000	.14479+04	.21798-02
2.6390	.12455-02	.98782-02	.10243-01	.71844+03	.33025-03	.18366-03	.00000	.00000	.14505+04	.55099-04
2.8420	.11745-02	.26235-00	.10178-01	.71844+03	.34203-03	.72149-02	.00000	.00000	.14480+04	.21645-02
2.8420	.11782-02	.10672-01	.10177-01	.71844+03	.33016-03	.20230-03	.00000	.00000	.14505+04	.60689-04
3.0450	.11070-02	.28457-00	.10086-01	.71844+03	.34280-03	.78364-02	.00000	.00000	.14478+04	.23509-02
3.0450	.11110-02	.14091-01	.10086-01	.71844+03	.32974-03	.26902-03	.00000	.00000	.14505+04	.80706-04
3.2480	.10385-02	.37886-00	.99679-02	.71844+03	.34790-03	.10336-01	.00000	.00000	.14468+04	.31008-02
3.2480	.10437-02	.79584-02	.99677-02	.71844+03	.33051-03	.12513-03	.00000	.00000	.14505+04	.37340-04
3.4510	.97369-03	.19877-00	.98235-02	.71844+03	.33912-03	.54875-02	.00000	.00000	.14486+04	.16463-02
3.4510	.97646-03	.67930-02	.98234-02	.71844+03	.33057-03	.12556-03	.00000	.00000	.14505+04	.37667-04
3.6540	.90672-03	.17897-00	.96527-02	.71844+03	.33822-03	.49504-02	.00000	.00000	.14487+04	.14851-02
3.6540	.90924-03	.82512-02	.96527-02	.71844+03	.33041-03	.15967-03	.00000	.00000	.14505+04	.47901-04
3.8570	.83892-03	.22100-00	.94557-02	.71844+03	.33984-03	.61154-02	.00000	.00000	.14484+04	.18346-02

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Garrett Business Forms, Inc.

3.8570	.84199-03	.77238-02	.94556-02	.71844+03	.33048-03	.14233-03	.00000	.00000	.14505+04	.42700-04
4.0600	.77192-03	.20291-00	.92323-02	.71844+03	.33905-03	.56220-02	.00000	.00000	.14485+04	.16866-02
4.0600	.77474-03	.71545-02	.92322-02	.71844+03	.33057-03	.13418-03	.00000	.00000	.14505+04	.40254-04
4.2630	.70491-03	.18750-00	.89825-02	.71844+03	.33757-03	.52622-02	.00000	.00000	.14487+04	.15787-02
4.2630	.70749-03	.62475-02	.89824-02	.71844+03	.33070-03	.11973-03	.00000	.00000	.14505+04	.35919-04
4.4660	.63803-03	.16302-00	.87064-02	.71844+03	.33562-03	.46610-02	.00000	.00000	.14489+04	.13983-02
4.4660	.64029-03	.68598-02	.87063-02	.71844+03	.32950-03	.51317-04	.00000	.00000	.14505+04	.15395-04
4.6690	.56946-03	.19483-00	.84039-02	.71844+03	.36652-03	.32614-02	.00000	.00000	.14480+04	.97843-03
4.6690	.57142-03	.46187-01	.84038-02	.71844+03	.36149-03	.88607-03	.00000	.00000	.14494+04	.26582-03
4.8720	.54774-03	.16045+01	.80743-02	.71844+03	.40016-03	.70246-02	.00000	.00000	.14794+04	.21074-02
4.8720	.54941-03	.17321-01	.80743-02	.71844+03	.40391-03	.34191-02	.00000	.00000	.14806+04	.10257-02
5.0750	.74842-03	.55204+02	.77438-02	.71844+03	.17011-01	.41067-00	.00000	.00000	.63105+03	.12320+00

MAIN SHELL PART NO 10

.0000	.74689-03	.55087+02	.77438-02	.71844+03	.17007-01	.40735-00	.00000	.00000	.90983+03	.26550+01
.0313	.11949-02	.16763-02	.77123-02	.71844+03	.11423-01	.14489+01	.00000	.00000	.39432+03	.28047-00
.0313	.11949-02	.16763+02	.77123-02	.71844+03	.11423-01	.14489+01	.00000	.00000	.39432+03	.28047-00
.0625	.14924-02	.30745+01	.76907-02	.71844+03	.49967-02	.17123+01	.00000	.00000	.98036+02	.98367-00
.0625	.14524-02	.30746+01	.76907-02	.71844+03	.49967-02	.17123+01	.00000	.00000	.98036+02	.98367-00
.0938	.15036-02	.19722-00	.76725-02	.71844+03	.16080-02	.17538+01	.00000	.00000	.36930+02	.12405+01
.0938	.15055-02	.19178-00	.76725-02	.71844+03	.16075-02	.17537+01	.00000	.00000	.36935+02	.12405+01
.1250	.13520-02	.81732+01	.76935-02	.71844+03	.82077-02	.16880+01	.00000	.00000	.21365+03	.51393-00

MAIN SHELL PART NO 11

.0000	.76535-02	.71844+03	.13520-02	.61781+01	.82072-02	.16879+01	.00000	.00000	.16616+02	.14887+03
.0288	.78918-02	.67773+03	.12769-02	.55455+01	.83376-02	.97192+01	.00000	.00000	.17248+02	.16360+03
.0288	.78918-02	.67773+03	.12769-02	.55457+01	.83376-02	.97192+01	.00000	.00000	.17250+02	.16360+03
.0576	.81336-02	.63696+03	.12018-02	.47907+01	.84498-02	.19152+02	.00000	.00000	.18004+02	.17877+03
.0864	.83784-02	.59613+03	.11267-02	.38796+01	.85507-02	.26330+02	.00000	.00000	.18913+02	.19468+03
.0864	.83784-02	.59613+03	.11267-02	.38796+01	.85507-02	.26330+02	.00000	.00000	.18913+02	.19468+03
.1152	.86261-02	.55523+03	.10517-02	.27663+01	.86488-02	.30873+02	.00000	.00000	.20025+02	.21169+03
.1152	.86261-02	.55523+03	.10517-02	.27663+01	.86488-02	.30873+02	.00000	.00000	.20025+02	.21169+03
.1440	.88766-02	.51424+03	.97664+03	.13861+01	.87539-02	.32244+02	.00000	.00000	.21404+02	.23034+03
.1440	.88766-02	.51424+03	.97664+03	.13861+01	.87539-02	.32244+02	.00000	.00000	.21404+02	.23034+03
.1728	.91305-02	.47314+03	.90160+03	.35352-00	.88787-02	.29679+02	.00000	.00000	.23141+02	.25139+03
.1728	.91305-02	.47314+03	.90160+03	.35352-00	.88787-02	.29679+02	.00000	.00000	.23141+02	.25139+03
.2016	.93884-02	.43190+03	.82658-03	.25893+01	.90395-02	.22047+02	.00000	.00000	.25375+02	.27596+03
.2016	.93884-02	.43190+03	.82658-03	.25893+01	.90395-02	.22047+02	.00000	.00000	.25375+02	.27596+03
.2304	.96517-02	.39047+03	.75157-03	.55298+01	.92582-02	.76260+01	.00000	.00000	.28312+02	.30578+03

MAIN SHELL PART NO 12



AIRSEARCH MANUFACTURING COMPANY
OF CALIFORNIA

Alpha Business Forms, Inc. 1

.0000	.75157+03	.55297+01	.96517-02	.39047+03	.92582-02	.76260+01	.00000	.00000	.11234+03	.22876+01
.0275	.56303+03	.45756+02	.95902-02	.39047+03	.45431-02	.68139+01	.00000	.00000	.60073+03	.20442+01
.0275	.56303+03	.45756+02	.95902-02	.39047+03	.45431-02	.68139+01	.00000	.00000	.60073+03	.20442+01
.0550	.49451+03	.54586+02	.95250-02	.39047+03	.59346+03	.53955+01	.00000	.00000	.77823+03	.16187+01
.0550	.49451+03	.54586+02	.95250-02	.39047+03	.59346+03	.53955+01	.00000	.00000	.77823+03	.16187+01
.0825	.52155+03	.58825+02	.94593-02	.39047+03	.23943-02	.38518+01	.00000	.00000	.70819+03	.11555+01
.0825	.52155+03	.58825+02	.94593-02	.39047+03	.23943-02	.38518+01	.00000	.00000	.70819+03	.11555+01
.1100	.61651+03	.78770+02	.93954-02	.39047+03	.43152-02	.20141+01	.00000	.00000	.46221+03	.60420+00
.1100	.61651+03	.78770+02	.93954-02	.39047+03	.43152-02	.20141+01	.00000	.00000	.46221+03	.60420+00
.1375	.74584+03	.12730+03	.93348-02	.39047+03	.47960-02	.74530-00	.00000	.00000	.12718+03	.22359+00
.1375	.74584+03	.12730+03	.93348-02	.39047+03	.47960-02	.74530-00	.00000	.00000	.12718+03	.22359+00
.1650	.85934+03	.20722+03	.92779-02	.39047+03	.29715-02	.52799+01	.00000	.00000	.12717+03	.22357+00
.1650	.85934+03	.20722+03	.92779-02	.39047+03	.29715-02	.52799+01	.00000	.00000	.12717+03	.22357+00
.1925	.85933+03	.20721+03	.92779-02	.39047+03	.29716-02	.52796+01	.00000	.00000	.16681+03	.15839+01
.1925	.85933+03	.20721+03	.92779-02	.39047+03	.29716-02	.52796+01	.00000	.00000	.16681+03	.15839+01
.2200	.87544+03	.30528+03	.92231-02	.39047+03	.25566-02	.12316+02	.00000	.00000	.20852+03	.36948+01
.2200	.87544+03	.30528+03	.92231-02	.39047+03	.25566-02	.12316+02	.00000	.00000	.20852+03	.36948+01
.1925	.87544+03	.30527+03	.92231-02	.39047+03	.25566-02	.12316+02	.00000	.00000	.20852+03	.36948+01
.2200	.86921+03	.38287+03	.91659-02	.39047+03	.13473-01	.21894+02	.00000	.00000	.32568+03	.65683+01
.2200	.86921+03	.38287+03	.91659-02	.39047+03	.13473-01	.21894+02	.00000	.00000	.32568+03	.65683+01
MAIN SHELL PART NO 13										
.0000	.91659-02	.39047+03	.66924+03	.38285+03	.13472-01	.21893+02	.00000	.00000	.40673+03	.15806+01
.0475	.99910+02	.32153+03	.55711-03	.37766+03	.20413-01	.80999+01	.00000	.00000	.41192+03	.66230+01
.0475	.99910+02	.32153+03	.55711-03	.37766+03	.20413-01	.80999+01	.00000	.00000	.41192+03	.66230+01
.0950	.11034+01	.25141+03	.44456+03	.36816+03	.22849+01	.27648+01	.00000	.00000	.42142+03	.13463+02
.0950	.11034+01	.25141+03	.44456+03	.36816+03	.22849+01	.27648+01	.00000	.00000	.42142+03	.13463+02
.1426	.11035+01	.25141+03	.44456+03	.36816+03	.22850+01	.27644+01	.00000	.00000	.42143+03	.13464+02
.1426	.12110+01	.17892+03	.33118+03	.34784+03	.21994+01	.10301+02	.00000	.00000	.44174+03	.19236+02
.1426	.12110+01	.17892+03	.33118+03	.34784+03	.21994+01	.10301+02	.00000	.00000	.44174+03	.19236+02
.1901	.13099+01	.10064+03	.21575+03	.29098+03	.19505+01	.13018+02	.00000	.00000	.44176+03	.19238+02
.1901	.13099+01	.10064+03	.21575+03	.29098+03	.19505+01	.13018+02	.00000	.00000	.44176+03	.19238+02
.2370	.13099+01	.10064+03	.21575+03	.29098+03	.19505+01	.13018+02	.00000	.00000	.49864+03	.25201+02
.2370	.13099+01	.10064+03	.21575+03	.29098+03	.19505+01	.13018+02	.00000	.00000	.49864+03	.25201+02
.1901	.13099+01	.10064+03	.21575+03	.29098+03	.19505+01	.13018+02	.00000	.00000	.49875+03	.25210+02
.2370	.13099+01	.10064+03	.21575+03	.29098+03	.19505+01	.13018+02	.00000	.00000	.78916+03	.41515+02

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GARRETT
AIRCRAFT MANUFACTURING COMPANY
OF CALIFORNIA

RALNINS SHELL STRESS ANALYSIS.....COLD END PRESSURE SHELL

4 JAN 74

DEFLECTIONS AND STRESSES FOR WAVE NUMBER NX# 0

BURST PRESSURE OF 2800 PSI PLUS TEMPERATURE LOADING

X	W	UPHI	UTHETA	BPHI	SPHI IN	SPHI OUT	STHETA IN	STHETA OUT	SFITH IN	SFITH OUT
MAIN SHELL PART NO 1										
.0000	.00000	.00000	.00000	.00000	.94063+05	.76278+05	-.54882+04	.54591+05	.00000	.00000
.2500	.65251-03	.37607-03	.00000	-.24566-02	.83288+04	.26114+05	-.44759+03	.98852+04	.00000	.00000
.2500	.65246-03	.37608-03	.00000	-.24561-02	.83313+04	.26116+05	-.45061+03	.98836+04	.00000	.00000
.5000	.94098-03	.67983-03	.00000	-.22550-03	.31776+04	.14607+05	.17929+05	.21357+05	.00000	.00000
.5000	.94093-03	.67983-03	.00000	-.22495-03	.31689+04	.14616+05	.17924+05	.21358+05	.00000	.00000
.7500	.95370-03	.96989-03	.00000	-.78896-04	.10268+05	.75165+04	.20714+05	.19888+05	.00000	.00000
.7500	.95369-03	.96989-03	.00000	-.78745-04	.10266+05	.75191+04	.20713+05	.19889+05	.00000	.00000
1.0000	.96184-03	.12579-02	.00000	.32599-03	.90337+03	.18688+05	.17783+05	.23661+05	.00000	.00000
1.0000	.96182-03	.12579-02	.00000	.32629-03	.90782+03	.18693+05	.17781+05	.23661+05	.00000	.00000
1.2500	.50156-03	.15663-02	.00000	.39336-02	.90782+03	.36400+05	-.11343+05	.51617+04	.00000	.00000
1.2500	.50155-03	.15663-02	.00000	.39338-02	.90619+05	.36404+05	-.11345+05	.51622+04	.00000	.00000
1.5000	-.54214-03	.19905-02	.00000	-.69925-06	.14504+06	-.12725+06	-.16245+05	-.97930+05	.00000	.00000
BRANCH SHELL PART NO 2										
.0000	-.19905-02	-.54218-03	.00000	-.97748-06	.13843+05	.13836+05	-.63903+05	-.63916+05	.00000	.00000
.1623	-.19903-02	-.37939-03	.00000	-.79628-06	.23641+05	.23636+05	-.54107+05	-.54115+05	.00000	.00000
.1623	-.19903-02	-.37939-03	.00000	-.79742-06	.23641+05	.23636+05	-.54107+05	-.54115+05	.00000	.00000
.3247	-.19902-02	-.26646-03	.00000	-.68845-06	.28638+05	.28635+05	-.49111+05	-.49117+05	.00000	.00000
.3247	-.19902-02	-.26646-03	.00000	-.68854-06	.28638+05	.28635+05	-.49111+05	-.49117+05	.00000	.00000
.4870	-.19901-02	-.18054-03	.00000	-.61870-06	.31526+05	.31524+05	-.46224+05	-.46228+05	.00000	.00000
.4870	-.19901-02	-.18054-03	.00000	-.61877-06	.31526+05	.31524+05	-.46224+05	-.46228+05	.00000	.00000
.6493	-.19900-02	-.11090-03	.00000	-.57250-06	.33344+05	.33343+05	-.44405+05	-.44409+05	.00000	.00000
.6493	-.19900-02	-.11090-03	.00000	-.57250-06	.33344+05	.33343+05	-.44405+05	-.44409+05	.00000	.00000
.8117	-.19899-02	-.51829-04	.00000	-.54154-06	.34562+05	.34562+05	-.43187+05	-.43191+05	.00000	.00000
.8117	-.19899-02	-.51829-04	.00000	-.54145-06	.34562+05	.34562+05	-.43187+05	-.43191+05	.00000	.00000
.9740	-.19898-02	.11710-10	.00000	-.52097-06	.35418+05	.35418+05	-.42331+05	-.42334+05	.00000	.00000
MAIN SHELL PART NO 3										
.0000	-.54218-03	.19905-02	.00000	-.97748-06	.14510+06	.12731+06	-.16229+05	-.97951+05	.00000	.00000
.1500	.30354-04	.22635-02	.00000	-.52594-02	.38054+04	.13979+05	-.28995+05	-.25943+05	.00000	.00000
.1500	.30351-04	.22635-02	.00000	-.52594-02	.38042+04	.13981+05	-.28996+05	-.25943+05	.00000	.00000
.3000	.67588-03	.24818-02	.00000	-.29838-02	.19084+05	.36869+05	-.24657+04	.14321+05	.00000	.00000
.3000	.67586-03	.24818-02	.00000	-.29838-02	.19084+05	.36869+05	-.24661+04	.14320+05	.00000	.00000
.4500	.93634-03	.26648-02	.00000	-.71844-03	.61260+04	.23911+05	.14897+05	.23909+05	.00000	.00000
.4500	.93633-03	.26648-02	.00000	-.71854-03	.61271+04	.23912+05	.14897+05	.23908+05	.00000	.00000
.6000	.96386-03	.28380-02	.00000	-.15217-03	.55633+04	.12222+05	.19828+05	.21826+05	.00000	.00000
.6000	.96387-03	.28380-02	.00000	-.15212-03	.55643+04	.12221+05	.19829+05	.21826+05	.00000	.00000

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Measure Business? Farms Inc-1

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AIRSEARCH MANUFACTURING COMPANY
OF CALIFORNIA

Master Bulletin Form, Inc. 1

ORIGINAL PAGE IS
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.1187	.65494-02	.11011-02	.00000	.29559-02	.13763+05	.10244+05	.76039+04	.12122+05	.00000	.00000
.1187	.65494-02	.11011-02	.00000	.29559-02	.13763+05	.10244+05	.76039+04	.12122+05	.00000	.00000
.2373	.69205-02	.97076-03	.00000	.32735-02	.61990+04	.28272+04	.13276+05	.17941+05	.00000	.00000
.2373	.69205-02	.97076-03	.00000	.32735-02	.61991+04	.28272+04	.13276+05	.17941+05	.00000	.00000
.3560	.73210-02	.84084-03	.00000	.34574-02	.15583+03	.29933+04	.18754+05	.23642+05	.00000	.00000
MAIN SHELL PART NO 7										
.0000	.73210-02	.84084-03	.00000	.34574-02	.15586+03	.29933+04	.18754+05	.23642+05	.00000	.00000
.0181	.73839-02	.82103-03	.00000	.34765-02	.61527+03	.37204+04	.19593+05	.24525+05	.00000	.00000
.0181	.73839-02	.82103-03	.00000	.34765-02	.61526+03	.37204+04	.19593+05	.24525+05	.00000	.00000
.0363	.74471-02	.80124-03	.00000	.34936-02	.13413+04	.43991+04	.20437+05	.25417+05	.00000	.00000
.0363	.74471-02	.80124-03	.00000	.34936-02	.13413+04	.43991+04	.20437+05	.25417+05	.00000	.00000
.0544	.75107-02	.78147-03	.00000	.35091-02	.20203+04	.50268+04	.21289+05	.26319+05	.00000	.00000
.0544	.75107-02	.78147-03	.00000	.35091-02	.20203+04	.50268+04	.21289+05	.26319+05	.00000	.00000
.0726	.75745-02	.76172-03	.00000	.35231-02	.26496+04	.56007+04	.22149+05	.27235+05	.00000	.00000
.0726	.75745-02	.76172-03	.00000	.35231-02	.26496+04	.56007+04	.22149+05	.27235+05	.00000	.00000
.0907	.76385-02	.74199-03	.00000	.35358-02	.32268+04	.61170+04	.23022+05	.28168+05	.00000	.00000
.0907	.76385-02	.74199-03	.00000	.35358-02	.32268+04	.61170+04	.23022+05	.28168+05	.00000	.00000
.1089	.77027-02	.72229-03	.00000	.35475-02	.37486+04	.65742+04	.23909+05	.29121+05	.00000	.00000
.1089	.77027-02	.72229-03	.00000	.35475-02	.37486+04	.65742+04	.23909+05	.29121+05	.00000	.00000
.1270	.77672-02	.70262-03	.00000	.35586-02	.42114+04	.69658+04	.24816+05	.30899+05	.00000	.00000
.1270	.77672-02	.70262-03	.00000	.35586-02	.42114+04	.69658+04	.24816+05	.30899+05	.00000	.00000
MAIN SHELL PART NO 8										
.0000	.17834-02	.75923-02	.00000	.35586-02	.27366+05	.42492+05	.74256+04	.16420+05	.00000	.00000
.0505	.19406-02	.76539-02	.00000	.26709-02	.24278+05	.40416+05	.24044+04	.23864+05	.00000	.00000
.1010	.20538-02	.77110-02	.00000	.18201-02	.19227+05	.36355+05	.10821+05	.28813+05	.00000	.00000
.1010	.20538-02	.77110-02	.00000	.18200-02	.19228+05	.36356+05	.10821+05	.28814+05	.00000	.00000
.1515	.21260-02	.77645-02	.00000	.10608-02	.12951+05	.31111+05	.17673+05	.31611+05	.00000	.00000
.2020	.21632-02	.78153-02	.00000	.43751-03	.60846+04	.25393+05	.22975+05	.32695+05	.00000	.00000
.2020	.21632-02	.78153-02	.00000	.43772-03	.60820+04	.25390+05	.22975+05	.32694+05	.00000	.00000
.2525	.21731-02	.78643-02	.00000	.14931-04	.87931+03	.19780+05	.26907+05	.32569+05	.00000	.00000
.3030	.21650-02	.79124-02	.00000	.27037-03	.76206+04	.14697+05	.29802+05	.31780+05	.00000	.00000
.3030	.21650-02	.79124-02	.00000	.27039-03	.76203+04	.14697+05	.29802+05	.31780+05	.00000	.00000
.3535	.21495-02	.79601-02	.00000	.30461-03	.14051+05	.10364+05	.32151+05	.30897+05	.00000	.00000
.4040	.21384-02	.80078-02	.00000	.87517-04	.20343+05	.67911+04	.34623+05	.30519+05	.00000	.00000
.4040	.21384-02	.80078-02	.00000	.87610-04	.20343+05	.67917+04	.34623+05	.30520+05	.00000	.00000
.4545	.21458-02	.80559-02	.00000	.43723-03	.26980+05	.37719+04	.38124+05	.31328+05	.00000	.00000
.5050	.21896-02	.81044-02	.00000	.13845-02	.34766+05	.95812+03	.43914+05	.34225+05	.00000	.00000
.5050	.21896-02	.81044-02	.00000	.13837-02	.34761+05	.96306+03	.43913+05	.34227+05	.00000	.00000
.5555	.22965-02	.81530-02	.00000	.29846-02	.44645+05	.17480+04	.53810+05	.40704+05	.00000	.00000
.6060	.25088-02	.82028-02	.00000	.56430-02	.56549+05	.24829+04	.70305+05	.53810+05	.00000	.00000
.6060	.25088-02	.82028-02	.00000	.56390-02	.56530+05	.24645+04	.70297+05	.53812+05	.00000	.00000
.6565	.28890-02	.82530-02	.00000	.95566-02	.62481+05	.11398+05	.94820+05	.80992+05	.00000	.00000
.7070	.34145-02	.83105-02	.00000	.82136-02	.53431+04	.12458+06	.10652+06	.14630+06	.00000	.00000



AIRSEARCH MANUFACTURING COMPANY
OF CALIFORNIA

MAIN SHELL PART NO 9

.0000	.22151-02	.87065-02	.00000	.82263-02	.49184+04	.12466+06	.10693+06	.14580+06	.00000	.00000
.2030	.20383-02	.89707-02	.00000	.59138-03	.62693+05	.57048+05	.12091+06	.11922+06	.00000	.00000
.2030	.20452-02	.89705-02	.00000	.56632-03	.62131+05	.57610+05	.12114+06	.11978+06	.00000	.00000
.4060	.19800-02	.92721-02	.00000	.34492-03	.60235+05	.59506+05	.12069+06	.12047+06	.00000	.00000
.4060	.19856-02	.92220-02	.00000	.32403-03	.59782+05	.59958+05	.12087+06	.12093+06	.00000	.00000
.6090	.19123-02	.94467-02	.00000	.34976-03	.60318+05	.59423+05	.12069+06	.12042+06	.00000	.00000
.6090	.19176-02	.94465-02	.00000	.33112-03	.59871+05	.59870+05	.12087+06	.12087+06	.00000	.00000
.8120	.18493-02	.96447-02	.00000	.33170-03	.59991+05	.59749+05	.12083+06	.12076+06	.00000	.00000
.8120	.18507-02	.96447-02	.00000	.32972-03	.59858+05	.59882+05	.12088+06	.12088+06	.00000	.00000
1.0150	.17782-02	.98167-02	.00000	.34835-03	.60291+05	.59449+05	.12070+06	.12045+06	.00000	.00000
1.0150	.17834-02	.98165-02	.00000	.32984-03	.59860+05	.59880+05	.12087+06	.12088+06	.00000	.00000
1.2180	.17111-02	.99622-02	.00000	.34728-03	.60278+05	.59463+05	.12071+06	.12046+06	.00000	.00000
1.2180	.17160-02	.99620-02	.00000	.33172-03	.59874+05	.59867+05	.12086+06	.12086+06	.00000	.00000
1.4210	.16500-02	.10081-01	.00000	.32452-03	.59784+05	.59957+05	.12091+06	.12096+06	.00000	.00000
1.4210	.16491-02	.10081-01	.00000	.32868-03	.59850+05	.59890+05	.12088+06	.12089+06	.00000	.00000
1.6240	.15732-02	.10174-01	.00000	.36014-03	.60560+05	.59181+05	.12059+06	.12018+06	.00000	.00000
1.6240	.15817-02	.10174-01	.00000	.33000-03	.59862+05	.59878+05	.12087+06	.12088+06	.00000	.00000
1.8270	.15099-02	.10241-01	.00000	.34589-03	.60236+05	.59505+05	.12072+06	.12050+06	.00000	.00000
1.8270	.15145-02	.10240-01	.00000	.32986-03	.59860+05	.59881+05	.12087+06	.12088+06	.00000	.00000
2.0300	.14422-02	.10281-01	.00000	.34668-03	.60273+05	.59467+05	.12071+06	.12047+06	.00000	.00000
2.0300	.14472-02	.10281-01	.00000	.32989-03	.59860+05	.59880+05	.12087+06	.12088+06	.00000	.00000
2.2330	.13751-02	.10294-01	.00000	.34618-03	.60270+05	.59471+05	.12071+06	.12047+06	.00000	.00000
2.2330	.13600-02	.10294-01	.00000	.32957-03	.59858+05	.59882+05	.12088+06	.12088+06	.00000	.00000
2.4360	.13069-02	.10282-01	.00000	.35029-03	.60340+05	.59400+05	.12068+06	.12040+06	.00000	.00000
2.4360	.13127-02	.10282-01	.00000	.33023-03	.59863+05	.59877+05	.12087+06	.12088+06	.00000	.00000
2.6390	.12417-02	.10243-01	.00000	.34268-03	.60173+05	.59567+05	.12075+06	.12057+06	.00000	.00000
2.6390	.12455-02	.10243-01	.00000	.33025-03	.59863+05	.59878+05	.12087+06	.12088+06	.00000	.00000
2.8420	.11745-02	.10178-01	.00000	.34203-03	.60171+05	.59570+05	.12075+06	.12057+06	.00000	.00000
2.8420	.11782-02	.10177-01	.00000	.33016-03	.59862+05	.59879+05	.12087+06	.12088+06	.00000	.00000
3.0450	.11070-02	.10086-01	.00000	.34280-03	.60197+05	.59544+05	.12074+06	.12055+06	.00000	.00000
3.0450	.11110-02	.10086-01	.00000	.32974-03	.59859+05	.59881+05	.12087+06	.12088+06	.00000	.00000
3.2480	.10385-02	.99679-02	.00000	.34790-03	.60301+05	.59440+05	.12070+06	.12044+06	.00000	.00000
3.2480	.10437-02	.99677-02	.00000	.33051-03	.59865+05	.59875+05	.12087+06	.12087+06	.00000	.00000
3.4510	.97369-03	.98235-02	.00000	.33912-03	.60099+05	.59642+05	.12078+06	.12064+06	.00000	.00000
3.4510	.97646-03	.98234-02	.00000	.33057-03	.59865+05	.59875+05	.12087+06	.12087+06	.00000	.00000
3.6540	.90672-03	.96527-02	.00000	.33822-03	.60076+05	.59664+05	.12079+06	.12067+06	.00000	.00000
3.6540	.90924-03	.96527-02	.00000	.33041-03	.59864+05	.59877+05	.12087+06	.12088+06	.00000	.00000
3.8570	.83892-03	.94557-02	.00000	.33984-03	.60125+05	.59615+05	.12077+06	.12062+06	.00000	.00000

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Master Inventory Form Dec 74

3.8570	.84199-03	.94556-02	.00000	.33048-03	.59864+05	.59876+05	.12087+06	.12087+06	.00000	.00000
4.0600	.77192-03	.92323-02	.00000	.33903-03	.60104+05	.59636+05	.12078+06	.12064+06	.00000	.00000
4.0600	.77474-03	.92322-02	.00000	.33057-03	.59865+05	.59876+05	.12087+06	.12087+06	.00000	.00000
4.2630	.70491-03	.89825-02	.00000	.33757-03	.60089+05	.59651+05	.12079+06	.12066+06	.00000	.00000
4.2630	.70749-03	.89824-02	.00000	.33070-03	.59865+05	.59875+05	.12087+06	.12087+06	.00000	.00000
4.4660	.63803-03	.87060-02	.00000	.33562-03	.60064+05	.59676+05	.12080+06	.12069+06	.00000	.00000
4.4660	.64029-03	.87063-02	.00000	.32950-03	.59868+05	.59872+05	.12087+06	.12087+06	.00000	.00000
4.6690	.56946-03	.84639-02	.00000	.36652-03	.60006+05	.59734+05	.12071+06	.12063+06	.00000	.00000
4.6690	.57142-03	.84638-02	.00000	.36149-03	.59833+05	.59907+05	.12077+06	.12079+06	.00000	.00000
4.8720	.54774-03	.80743-02	.00000	.40016-03	.60163+05	.59578+05	.12337+06	.12320+06	.00000	.00000
4.8720	.54991-03	.80743-02	.00000	.40391-03	.60013+05	.59728+05	.12343+06	.12334+06	.00000	.00000
5.0750	.74842-03	.77438-02	.00000	.17011-01	.76981+05	.42759+05	.57721+05	.47454+05	.00000	.00000
MAIN SHELL PART NO 10										
.0000	.74689-03	.77438-02	.00000	.17007-01	.85139+05	.13295+05	.60257+05	.30727+05	.00000	.00000
.0313	.11949-02	.77123-02	.00000	.11423-01	.10076+06	.28918+05	.39168+05	.26387+03	.00000	.00000
.0313	.11949-02	.77123-02	.00000	.11423-01	.10076+06	.28918+05	.39168+05	.26387+03	.00000	.00000
.0625	.14524-02	.76907-02	.00000	.49967-02	.10471+06	.32869+05	.25539+05	.15735+05	.00000	.00000
.0625	.14524-02	.76907-02	.00000	.49967-02	.10471+06	.32869+05	.25539+05	.15735+05	.00000	.00000
.0938	.15056-02	.76725-02	.00000	.16080-02	.10534+06	.33491+05	.22671+05	.18978+05	.00000	.00000
.0938	.15055-02	.76725-02	.00000	.16075-02	.10533+06	.33490+05	.22670+05	.18977+05	.00000	.00000
.1230	.13520-02	.76535-02	.00000	.82077-02	.10435+06	.32505+05	.31211+05	.29845+04	.00000	.00000
MAIN SHELL PART NO 11										
.0000	.76535-02	.13520-02	.00000	.82072-02	.37655+03	.45576+03	.36810+05	.36596+05	.00000	.00000
.0288	.78918-02	.12769-02	.00000	.83376-02	.24318+04	.23607+04	.40445+05	.40224+05	.00000	.00000
.0576	.81336-02	.12018-02	.00000	.84498-02	.47525+04	.46911+04	.40445+05	.40224+05	.00000	.00000
.0576	.81336-02	.12018-02	.00000	.84498-02	.47525+04	.46911+04	.40445+05	.40224+05	.00000	.00000
.0864	.83784-02	.11267-02	.00000	.85507-02	.65165+04	.64668+04	.44192+05	.43961+05	.00000	.00000
.1152	.86261-02	.10517-02	.00000	.86488-02	.76293+04	.75939+04	.44192+05	.43961+05	.00000	.00000
.1152	.86261-02	.10517-02	.00000	.86488-02	.76293+04	.75939+04	.44192+05	.43961+05	.00000	.00000
.1440	.88766-02	.97664-03	.00000	.87539-02	.79587+04	.79409+04	.52320+05	.52064+05	.00000	.00000
.1440	.88766-02	.97664-03	.00000	.87539-02	.79587+04	.79409+04	.52320+05	.52064+05	.00000	.00000
.1728	.91305-02	.90160-03	.00000	.88787-02	.73151+04	.73197+04	.56927+05	.56653+05	.00000	.00000
.2016	.93884-02	.82658-03	.00000	.90395-02	.54191+04	.54523+04	.62128+05	.61831+05	.00000	.00000
.2016	.93884-02	.82658-03	.00000	.90395-02	.54191+04	.54523+04	.62128+05	.61831+05	.00000	.00000
.2304	.96517-02	.75157-03	.00000	.92582-02	.18447+04	.19156+04	.75571+05	.75208+05	.00000	.00000

MAIN SHELL PART NO 12

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OF CALIFORNIA

Master Equipment Form 1

.0000	.75157-03	.96517-02	.00000	.92582-02	.57591+05	1.88828+05	-.17469+05	.26456+05	.00000	.00000
.0275	.56303-03	.95902-02	.00000	.45431-02	.49795+05	.81032+05	.44052+04	.43653+05	.00000	.00000
.0275	.56303-03	.95902-02	.00000	.45431-02	.49795+05	.81032+05	.44052+04	.43653+05	.00000	.00000
.0550	.49451-03	.95250-02	.00000	.59345-03	.36178+05	.67416+05	.15590+05	.46668+05	.00000	.00000
.0550	.49451-03	.95250-02	.00000	.59345-03	.36178+05	.67416+05	.15590+05	.46668+05	.00000	.00000
.0825	.52155-03	.94593-02	.00000	.23943-02	.21358+05	.52596+05	.17234+05	.39421+05	.00000	.00000
.0825	.52155-03	.94593-02	.00000	.23943-02	.21358+05	.52596+05	.17234+05	.39421+05	.00000	.00000
.1100	.61651-03	.93954-02	.00000	.43152-02	.37169+04	.34955+05	.12687+05	.24289+05	.00000	.00000
.1100	.61651-03	.93954-02	.00000	.43152-02	.37169+04	.34955+05	.12687+05	.24289+05	.00000	.00000
.1375	.74584-03	.93348-02	.00000	.47960-02	.22774+05	.84639+04	.72535+04	.29406+04	.00000	.00000
.1375	.74584-03	.93348-02	.00000	.47960-02	.22774+05	.84639+04	.72535+04	.29406+04	.00000	.00000
.1650	.85934-03	.92779-02	.00000	.29715-02	.66306+05	.35068+05	.85332+04	.21879+05	.00000	.00000
.1650	.85934-03	.92779-02	.00000	.29715-02	.66306+05	.35068+05	.85332+04	.21879+05	.00000	.00000
.1925	.87544-03	.92231-02	.00000	.25566-02	.13385+06	.10261+06	.27129+05	.43811+05	.00000	.00000
.1925	.87544-03	.92231-02	.00000	.25566-02	.13385+06	.10261+06	.27129+05	.43811+05	.00000	.00000
.2200	.66921-03	.91659-02	.00000	.13473-01	.22581+06	.19457+06	.76083+05	.50029+05	.00000	.00000
.2200	.66921-03	.91659-02	.00000	.13473-01	.22581+06	.19457+06	.76083+05	.50029+05	.00000	.00000
MAIN SHELL PART NO 13										
.0000	.91659-02	.66924-03	.00000	.13472-01	.11817+06	.96293+05	.19362+05	.38791+04	.00000	.00000
.0475	.99910-02	.55711-03	.00000	.20413-01	.50463+05	.28883+05	.20670+05	.44208+05	.00000	.00000
.0475	.99910-02	.55711-03	.00000	.20413-01	.50463+05	.28883+05	.20670+05	.44208+05	.00000	.00000
.0950	.11034-01	.44456-03	.00000	.22849-01	.30231+04	.24061+05	.53902+05	.77984+05	.00000	.00000
.0950	.11034-01	.44456-03	.00000	.22849-01	.30231+04	.24061+05	.53902+05	.77984+05	.00000	.00000
.1426	.12110-01	.33116-03	.00000	.21994-01	.40517+05	.60394+05	.81597+05	.10684+06	.00000	.00000
.1426	.12110-01	.33116-03	.00000	.21994-01	.40517+05	.60394+05	.81597+05	.10684+06	.00000	.00000
.1901	.13099-01	.21576-03	.00000	.19505-01	.85450+05	.72074+05	.10919+06	.13768+06	.00000	.00000
.1901	.13099-01	.21576-03	.00000	.19505-01	.85450+05	.72074+05	.10919+06	.13768+06	.00000	.00000
.2376	.13997-01	.21575-03	.00000	.19513-01	.55443+05	.72070+05	.10923+06	.13773+06	.00000	.00000
.2376	.13997-01	.21575-03	.00000	.19513-01	.55443+05	.72070+05	.10923+06	.13773+06	.00000	.00000

FORM NO WHICH INDICATES END OF JOB. EXIT CALLED

ORIGINAL PAGE IS
OF POOR QUALITY

DATE 21 JAN 74
PART NO. 952600
PREPARED BY MORRIS

CALC. NO. C6263 SHEET NO. 8-41
MODEL NO. 1/4 W. V.M.
CHECKED BY _____

8.3 SHELL DEFLECTION

THE DEFLECTION AT THE TIP OF THE COLD END SHELL DUE TO SELF-INDUCED VIBRATION WAS DETERMINED BY USING COMPUTER PROGRAM VOZ5.

THE MODEL USED IN THE ANALYSIS IS SHOWN ON PAGE 8-41. THIS MODEL WAS ALSO USED TO FIND THE FIRST MODE FREQUENCY AND TIP DEFLECTION DUE TO RANDOM VIBRATION.

THE RESULTS WERE:

TIP DEFLECTIONS DUE TO SELF INDUCED VIB = 8.46×10^{-6} IN.

(REF. PG. 8-46)

FIRST MODE FREQUENCY = $f = 241$ CPS.

(REF PG 8-49)

TIP DEFLECTION DUE TO RANDOM VIB. = 0.00086 IN. (REF. PG. 8-52)

THE TIP DEFLECTION DUE TO SELF-INDUCED VIBRATION (8.46×10^{-6} IN) IS MUCH LESS THAN THE SPECIFIED MAXIMUM OF 0.000200 IN.

THE FIRST MODE FREQUENCY, WITH AN ASSUMED AMPLIFICATION FACTOR OF 10, GIVES A RANDOM VIBRATION LOAD OF 35.0 G'S

APPLYING 35.0 G'S TO THE SHELL RESULTED IN 0.0086 INCHES DEFLECTION AT THE TIP, WHICH IS GREATER THAN THE 0.005 INCH RADIAL CLEARANCE. THEREFORE, UNDER RANDOM VIBRATION LOADING, CONTACT WILL OCCUR BETWEEN THE SHELL AND DISPLACER. SUCH CONTACT, HOWEVER, IS NOT DETRIMENTAL BECAUSE:

- 1) THE DEFLECTIONS ARE ELASTIC AND MOMENTARY. THE STRESS ASSOCIATED WITH THE MAX DEFLECTION AND MAX OPERATING PRESSURE ARE MUCH LOWER THAN THE ELASTIC LIMIT.
- 2) THE PROBABLE CONSEQUENCE OF SUCH CONTACT WOULD BE A MOMENTARY STALLING OF THE ENGINE, AFTER WHICH THE ENGINE WOULD CONTINUE TO FUNCTION.



DATE 17 Nov 72
PART NO. 852600
PREPARED BY MURRAY TO

CALC. NO. C6263 SHEET NO. 8-42
MODEL NO. 1/4 W. V. H.
CHECKED BY _____

8.3.1 DEFLECTION DUE TO SELF-INDUCED VIBRATION

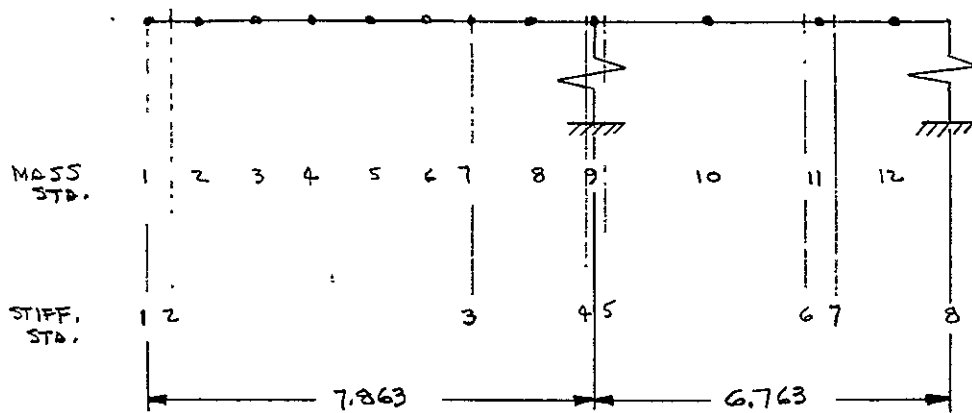


FIG 8-3 COLD END SHELL DEFLECTION MODEL



DATE 17 Nov 72
 PART NO. 852600
 PREPARED BY MORRIS T.

CALC. NO. C6243 SHEET NO. 8-43
 MODEL NO. 1/4 IN. V. 8M
 CHECKED BY _____

8.3.1 DEFLECTION DUE TO SELF INDUCED VIBRATION

$$M_1 = .078 / 386 = 0.00020207 \text{ LB-SEC}^2/\text{IN.}$$

$$M_2 = M_3 = M_4 = M_5 = M_6 = \frac{1.00}{5.3125} \times \frac{1.00}{386} = 0.00048766 \text{ LB-SEC}^2/\text{IN.}$$

$$M_7 = \frac{1.00}{5.3125} \times \frac{.3125}{386} = 0.00015239 \text{ LB-SEC}^2/\text{IN.}$$

$$M_8 = \frac{.234}{386} (1.260 - 1.072)(2.00) = 0.00052988 \text{ LB-SEC}^2/\text{IN.}$$

$$X_{8CG} = 6.3125 + 1.00 = 7.3125$$

$$M_9 = \frac{.234}{386} (1.260 - 1.072)(.30) = .000079482 \text{ LB-SEC}^2/\text{IN.}$$

$$X_{9CG} = 7.3125 + .15 = 7.4625$$

$$M_{10} = \frac{.234}{386} (1.260 - 1.072)(3.50) = .00092728 \text{ LB-SEC}^2/\text{IN.}$$

$$X_{10CG} = 7.4625 + 1.75 = 9.2125$$

$$M_{11} = \frac{(.83 + .26)}{386} = 0.0022539 \text{ (UNBALANCE OF HT + CNO DISPLACEMENT)}$$

$$X_{11CG} = 9.2125 + .25 = 9.4625$$

$$M_{12} = \frac{.234}{386} (2.380 - 2.250)(2.00) = .00071658 \text{ LB-SEC}^2/\text{IN.}$$

$$X_{12CG} = 9.4625 + 1.00 = 10.4625$$



DATE 17 Nov 72
 PART NO. 852600
 PREPARED BY MORIMOTO

CALC. NO. C6263 SHEET NO. 8-44
 MODEL NO. 1/4 W. V.M
 CHECKED BY _____

8.3.1 DEFLECTION DUE TO SELF INDUCED VIBRATION

SUPPORT STIFFNESS

MOMENT RESTRAINT AT "FIXED" SUPPORT

$$a = 1.6 \quad t = .30$$

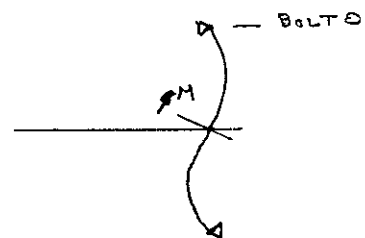
$$L = .6$$

$$b/a = .375$$

$$\theta = \gamma \frac{M}{E t^3}$$

$$\gamma = .30 \quad (\text{ROARK, p. 216})$$

$$\frac{M}{\theta} = \gamma E t^3 = .30 \times 29.8 \times 10^6 \times .30^3 = 242,000 \text{ IN-LB/RAD.}$$



IN-PLANE STIFFNESS WILL BE HIGH.

APPROXIMATE BY USING TWO PLATES - ONE IN TENSION, ONE IN COMP.

$$L = a - b = 1.00 \quad A = .30 \times 1.20 = .360 \text{ IN}^2$$

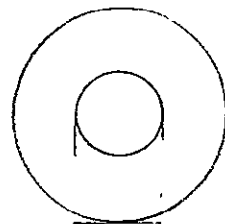
$$w = z b = 1.20$$

$$t = .30$$

$$K = \frac{2AG}{L} = \frac{.360 \times 29.8 \times 10^6}{1.00} \times 2$$

$$= 10.7 \times 10^6 \text{ LB/IN. X-}$$

$$= \underline{21.4} \times 10^6 \text{ LB/IN}$$



AIRESEARCH MANUFACTURING COMPANY
 OF CALIFORNIA

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V.M. CYROGENIC ENGINE - COLD END SHELL DYNAMIC RESPONSE AT 400 RPM
MIKE MORIMOTO JAN 74



AIRCOR MANUFACTURING COMPANY
OF CALIFORNIA

STATION	XCG	MASS	IP	ID	F11R	F12R	F21R	F22R
1	6.0000E-01	2.0207E-04	0.0	0.0	0.0	0.0	0.0	0.0
2	1.5000E 00	4.8766E-04	0.0	0.0	-2.1815E-06	-4.4236E-06	-3.1162E-06	8.3776E-06
3	2.5000E 00	4.8766E-04	0.0	0.0	-3.2288E-06	-3.2016E-06	-3.2016E-06	6.4033E-06
4	3.5000E 00	4.8766E-04	0.0	0.0	-3.2288E-06	-3.2016E-06	-3.2016E-06	6.4033E-06
5	4.5000E 00	4.8766E-04	0.0	0.0	-3.2288E-06	-3.2016E-06	-3.2016E-06	6.4033E-06
6	5.5000E 00	4.8766E-04	0.0	0.0	-3.2288E-06	-3.2016E-06	-3.2016E-06	6.4033E-06
7	6.5125E 00	1.5239E-04	0.0	0.0	-2.9181E-06	-2.1136E-06	-2.1136E-06	5.2027E-06
8	7.3125E 00	5.2988E-04	0.0	0.0	-3.9232E-07	-2.8488E-07	-2.8488E-07	5.6975E-07
9	8.4625E 00	7.9480E-05	0.0	0.0	-4.1595E-07	-3.7675E-07	-3.7675E-07	6.5522E-07
10	1.0362E 01	9.2728E-04	0.0	0.0	-2.7451E-07	-1.0284E-06	-1.0284E-06	1.0825E-06
11	1.2362E 01	2.2539E-03	0.0	0.0	-2.1489E-07	-1.1395E-06	-1.1395E-06	1.1395E-06
12	1.3612E 01	7.1658E-04	0.0	0.0	-4.3152E-07	-2.1394E-07	-9.8353E-08	2.4984E-07

STATION	VR	VI	MR	MI	F11I	F12I	F21I	F22I
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

STATION	DYR	DYI	DYER	DYEI	EYR	EYI	ETHER	ETHEI
1	0.0	0.0	0.0	0.0	1.0000E-03	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	1.0000E-03	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	1.0000E-03	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	2.0000E-01	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

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AIRSEARCH MANUFACTURING COMPANY
OF CALIFORNIA

V.M. CYROGENIC ENGINE - COLD END SHELL DYNAMIC RESPONSE AT 800 RPM
MIKE MORIMOTO JAN 74

VIBX RPM	VIBX CPS	VIBX RAD/SEC	SYS RPM	AXIAL P	SHAFT/WHIRL RATIO				
800.0	13.33	83.78	0.0	0.0	1.000				
STATION	ABSY	PHASE	THETA	SHEAR	MOMENT	ZK	REZK	IMZK	ZI
1	8.4557E-06	1.8000E 02	9.3399E-07	1.4062E-03	0.0	0.0	0.0	0.0	0.0
2	7.6182E-06	1.8000E 02	9.3837E-07	1.3801E-03	1.2656E-03	0.0	0.0	0.0	0.0
3	6.6863E-06	1.8000E 02	9.5089E-07	4.7799E-03	2.6457E-03	0.0	0.0	0.0	0.0
4	5.7363E-06	1.8000E 02	9.8313E-07	4.7602E-03	7.4256E-03	0.0	0.0	0.0	0.0
5	4.7448E-06	1.8000E 02	1.0459E-06	8.1666E-03	1.2186E-02	0.0	0.0	0.0	0.0
6	3.6862E-06	1.8000E 02	1.1501E-06	8.1539E-03	2.0352E-02	0.0	0.0	0.0	0.0
7	2.7325E-06	1.8000E 02	1.2732E-06	8.1510E-03	2.6977E-02	0.0	0.0	0.0	0.0
8	1.4548E-06	1.8000E 02	1.2909E-06	8.1456E-03	3.5128E-02	0.0	0.0	0.0	0.0
9	3.9561E-08	0.0	1.3170E-06	8.3845E-01	3.8321E-01	2.1400E 07	2.1400E 07	0.0	2.4200E 05
10	3.1455E-06	0.0	8.4791E-07	8.3843E-01	1.2298E 00	0.0	0.0	0.0	0.0
11	3.6201E-06	0.0	1.5089E-06	2.3254E 00	2.2067E 00	0.0	0.0	0.0	0.0
12	1.0866E-07	0.0	2.0064E-06	4.6384E-11	1.1440E-12	2.1400E 07	2.1400E 07	0.0	0.0

VIBX RPM	VIBX CPS	VIBX RAD/SEC	SYS RPM	AXIAL P	SHAFT/WHIRL RATIO				
810.0	13.50	84.82	0.0	0.0	1.000				
STATION	ABSY	PHASE	THETA	SHEAR	MOMENT	ZK	REZK	IMZK	ZI
1	8.6693E-06	1.8000E 02	9.5764E-07	1.4413E-03	0.0	0.0	0.0	0.0	0.0
2	7.8105E-06	1.8000E 02	9.6213E-07	1.4139E-03	1.2971E-03	0.0	0.0	0.0	0.0
3	6.8488E-06	1.8000E 02	9.7496E-07	4.8985E-03	2.7110E-03	0.0	0.0	0.0	0.0
4	5.8810E-06	1.8000E 02	1.0080E-06	4.8779E-03	7.6095E-03	0.0	0.0	0.0	0.0
5	4.8644E-06	1.8000E 02	1.0723E-06	8.3695E-03	1.2487E-02	0.0	0.0	0.0	0.0
6	3.7791E-06	1.8000E 02	1.1791E-06	8.3562E-03	2.5857E-02	0.0	0.0	0.0	0.0
7	2.8013E-06	1.8000E 02	1.3053E-06	8.3532E-03	2.7646E-02	0.0	0.0	0.0	0.0
8	1.4915E-06	1.8000E 02	1.3234E-06	8.3475E-03	3.6000E-02	0.0	0.0	0.0	0.0
9	4.0556E-08	0.0	1.3501E-06	8.5954E-01	3.7233E-01	2.1400E 07	2.1400E 07	0.0	2.4200E 05
10	3.2247E-06	0.0	8.6925E-07	8.5952E-01	1.2608E 00	0.0	0.0	0.0	0.0
11	3.7112E-06	0.0	1.5469E-06	2.3839E 00	2.9798E 00	0.0	0.0	0.0	0.0
12	1.1139E-07	0.0	2.0569E-06	2.8194E-11	6.8212E-13	2.1400E 07	2.1400E 07	0.0	0.0

VIBX RPM	VIBX CPS	VIBX RAD/SEC	SYS RPM	AXIAL P	SHAFT/WHIRL RATIO				
820.0	13.67	85.87	0.0	0.0	1.000				
STATION	ABSY	PHASE	THETA	SHEAR	MOMENT	ZK	REZK	IMZK	ZI
1	8.8855E-06	1.8000E 02	9.8159E-07	1.4768E-03	0.0	0.0	0.0	0.0	0.0
2	8.0053E-06	1.8000E 02	9.8620E-07	1.4480E-03	1.3291E-03	0.0	0.0	0.0	0.0
3	7.0195E-06	1.8000E 02	9.9934E-07	5.0186E-03	2.7771E-03	0.0	0.0	0.0	0.0
4	6.0275E-06	1.8000E 02	1.0332E-06	4.9969E-03	7.7956E-03	0.0	0.0	0.0	0.0
5	4.9854E-06	1.8000E 02	1.0991E-06	8.5748E-03	1.2793E-02	0.0	0.0	0.0	0.0
6	3.8731E-06	1.8000E 02	1.2085E-06	8.5609E-03	2.1367E-02	0.0	0.0	0.0	0.0
7	2.8710E-06	1.8000E 02	1.3377E-06	8.5577E-03	2.8323E-02	0.0	0.0	0.0	0.0
8	1.5285E-06	1.8000E 02	1.3563E-06	8.5517E-03	3.6881E-02	0.0	0.0	0.0	0.0
9	4.1563E-08	0.0	1.3837E-06	8.8090E-01	3.8157E-01	2.1400E 07	2.1400E 07	0.0	2.4200E 05
10	3.3048E-06	0.0	8.9085E-07	8.8087E-01	1.2921E 00	0.0	0.0	0.0	0.0
11	3.8034E-06	0.0	1.5853E-06	2.4431E 00	3.0539E 00	0.0	0.0	0.0	0.0
12	1.1416E-07	0.0	2.1080E-06	1.0914E-11	2.4514E-13	2.1400E 07	2.1400E 07	0.0	0.0

SEARCHING COMPLETED FROM 8.3776E 01 TO 8.5870E 01 RAD/SEC

ORIGINAL PAGE IS
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AIRSEARCH MANUFACTURING COMPANY
OF CALIFORNIA

V.M. CYROGENIC ENGINE - COLD END SHELL DYNAMIC RESPONSE AT 400 RPM
MIKE MORIMOTO JAN 74

VIBXRPK<	VIBXCPK<	VIBXRAD/SEC	SYSRPM	AXIAL P	SHAFT/WHIRL RATIO				
400.0	6.67	41.89	0.0	0.0	1.000				
STATION	ABSY	PHASE	THETA	SHEAR	MOMENT	ZK	REZK	IMZK	ZI
1	2.1081E-06	1.8000E 02	2.3235E-07	3.5380E-04	0.0	0.0	0.0	0.0	0.0
2	1.8997E-06	1.8000E 02	2.5345E-07	3.5218E-04	3.1842E-04	0.0	0.0	0.0	0.0
3	1.6664E-06	1.8000E 02	2.3661E-07	1.2064E-03	6.7060E-04	0.0	0.0	0.0	0.0
4	1.4315E-06	1.8000E 02	2.4477E-07	1.2052E-03	1.8770E-03	0.0	0.0	0.0	0.0
5	1.1846E-06	1.8000E 02	2.6065E-07	2.0598E-03	3.0822E-03	0.0	0.0	0.0	0.0
6	9.2078E-07	1.8000E 02	2.8698E-07	2.0590E-03	5.1420E-03	0.0	0.0	0.0	0.0
7	6.8275E-07	1.8000E 02	3.1808E-07	2.0588E-03	6.8149E-03	0.0	0.0	0.0	0.0
8	3.6353E-07	1.8000E 02	3.2255E-07	2.0585E-03	8.8738E-03	0.0	0.0	0.0	0.0
9	9.8919E-09	0.0	3.2914E-07	2.0963E-01	9.0893E-02	2.1400E 07	2.1400E 07	0.0	2.4200E 05
10	7.8628E-07	0.0	2.1196E-07	2.0962E-01	3.0740E-01	0.0	0.0	0.0	0.0
11	9.0496E-07	0.0	3.7719E-07	5.8132E-01	7.2664E-01	0.0	0.0	0.0	0.0
12	2.7164E-08	0.0	5.0156E-07	1.2506E-12	2.4869E-14	2.1400E 07	2.1400E 07	0.0	0.0

VIBXRPK<	VIBXCPK<	VIBXRAD/SEC	SYSRPM	AXIAL P	SHAFT/WHIRL RATIO				
410.0	6.83	42.94	0.0	0.0	1.000				
STATION	ABSY	PHASE	THETA	SHEAR	MOMENT	ZK	REZK	IMZK	ZI
1	2.2149E-06	1.8000E 02	2.4413E-07	3.7167E-04	0.0	0.0	0.0	0.0	0.0
2	1.9960E-06	1.8000E 02	2.4529E-07	3.6988E-04	3.3451E-04	0.0	0.0	0.0	0.0
3	1.7508E-06	1.8000E 02	2.4861E-07	1.2673E-03	7.0439E-04	0.0	0.0	0.0	0.0
4	1.5040E-06	1.8000E 02	2.5718E-07	1.2659E-03	1.9717E-03	0.0	0.0	0.0	0.0
5	1.2446E-06	1.8000E 02	2.7388E-07	2.1638E-03	3.2376E-03	0.0	0.0	0.0	0.0
6	9.6740E-07	1.8000E 02	3.0152E-07	2.1629E-03	5.4013E-03	0.0	0.0	0.0	0.0
7	7.1732E-07	1.8000E 02	3.3419E-07	2.1627E-03	7.1587E-03	0.0	0.0	0.0	0.0
8	3.8194E-07	1.8000E 02	3.3888E-07	2.1623E-03	9.3214E-03	0.0	0.0	0.0	0.0
9	1.0393E-08	0.0	3.4581E-07	2.2024E-01	9.5493E-02	2.1400E 07	2.1400E 07	0.0	2.4200E 05
10	8.2609E-07	0.0	2.2269E-07	2.2024E-01	3.2296E-01	0.0	0.0	0.0	0.0
11	9.5078E-07	0.0	3.9629E-07	6.1074E-01	7.6343E-01	0.0	0.0	0.0	0.0
12	2.8539E-08	0.0	5.2695E-07	2.0066E-11	4.9738E-13	2.1400E 07	2.1400E 07	0.0	0.0

VIBXRPK<	VIBXCPK<	VIBXRAD/SEC	SYSRPM	AXIAL P	SHAFT/WHIRL RATIO				
420.0	7.00	43.98	0.0	0.0	1.000				
STATION	ABSY	PHASE	THETA	SHEAR	MOMENT	ZK	REZK	IMZK	ZI
1	2.3244E-06	1.8000E 02	2.5620E-07	3.8998E-04	0.0	0.0	0.0	0.0	0.0
2	2.0946E-06	1.8000E 02	2.5742E-07	3.8801E-04	3.5099E-04	0.0	0.0	0.0	0.0
3	1.8373E-06	1.8000E 02	2.6091E-07	1.3296E-03	7.3899E-04	0.0	0.0	0.0	0.0
4	1.5784E-06	1.8000E 02	2.6990E-07	1.3281E-03	2.0686E-03	0.0	0.0	0.0	0.0
5	1.3061E-06	1.8000E 02	2.8740E-07	2.2703E-03	3.3967E-03	0.0	0.0	0.0	0.0
6	1.0152E-06	1.8000E 02	3.1642E-07	2.2693E-03	5.6670E-03	0.0	0.0	0.0	0.0
7	7.5274E-07	1.8000E 02	3.5069E-07	2.2691E-03	7.5108E-03	0.0	0.0	0.0	0.0
8	4.0080E-07	1.8000E 02	3.5562E-07	2.2687E-03	9.7799E-03	0.0	0.0	0.0	0.0
9	1.0906E-08	0.0	3.6288E-07	2.3111E-01	1.0021E-01	2.1400E 07	2.1400E 07	0.0	2.4200E 05
10	8.6688E-07	0.0	2.3368E-07	2.3111E-01	3.3891E-01	0.0	0.0	0.0	0.0
11	9.9772E-07	0.0	4.1585E-07	6.4090E-01	8.0113E-01	0.0	0.0	0.0	0.0
12	2.9948E-08	0.0	5.5297E-07	9.0949E-12	1.8474E-13	2.1400E 07	2.1400E 07	0.0	0.0

SEARCHING COMPLETED FROM 4.1888E 01 TO 4.3982E 01 RAD/SEC

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V.M. CYROGENIC ENGINE - COLD END SHELL FREQUENCY

MIKE MORIMOTO JAN 74

STATION	XCG	MASS	IP	ID	F11R	F12R	F21R	F22R
1	6.0000E-01	2.0207E-04	0.0	0.0	0.0	0.0	0.0	0.0
2	1.5000E 00	4.8766E-04	0.0	0.0	-2.1815E-06	-4.4236E-06	-3.1162E-06	8.3776E-06
3	2.5000E 00	4.8766E-04	0.0	0.0	-3.2288E-06	-3.2016E-06	-3.2016E-06	6.4033E-06
4	3.5000E 00	4.8766E-04	0.0	0.0	-3.2288E-06	-3.2016E-06	-3.2016E-06	6.4033E-06
5	4.5000E 00	4.8766E-04	0.0	0.0	-3.2288E-06	-3.2016E-06	-3.2016E-06	6.4033E-06
6	5.5000E 00	4.8766E-04	0.0	0.0	-3.2288E-06	-3.2016E-06	-3.2016E-06	6.4033E-06
7	6.3125E 00	1.5239E-04	0.0	0.0	-2.9181E-06	-2.1136E-06	-2.1136E-06	5.2027E-06
8	7.3125E-00	5.2988E-04	0.0	0.0	-3.9232E-07	-2.8488E-07	-2.8488E-07	5.6975E-07
9	8.4625E 00	7.9480E-05	0.0	0.0	-4.1595E-07	-3.7675E-07	-3.7675E-07	6.5522E-07
10	1.0362E 01	9.2728E-04	0.0	0.0	-2.7451E-07	-1.0284E-06	-1.0284E-06	1.0825E-06
11	1.2362E 01	2.2539E-03	0.0	0.0	-2.1489E-07	-1.1395E-06	-1.1395E-06	1.1395E-06
12	1.3612E 01	7.1658E-04	0.0	0.0	-4.3152E-07	-2.1394E-07	-9.8353E-08	2.4984E-07

STATION	VR	VI	MR	MI	F11I	F12I	F21I	F22I
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

STATION	DYR	DYI	OTHER	DTHEI	EYR	EYI	ETHER	ETHEI
1	0.0	0.0	0.0	0.0	1.0000E-03	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	1.0000E-03	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	1.0000E-03	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	2.0000E-01	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0


 AIRRESEARCH MANUFACTURING COMPANY
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 ORIGINAL PAGE IS
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V.M. CYROGENIC ENGINE - COLO END SHELL FREQUENCY

MIKE MORIMOTO JAN 74



GARRETT
AIRCRAFT MANUFACTURING COMPANY
OF CALIFORNIA

VIBX RPM	VIBX CPS	VIBX RAD/SEC	SYS RPM	AXIAL P	SHAFT/WHIRL RATIO
14456.6	240.94	1513.89	0.0	0.0	1.000

STATION	ABSX	PHASE	THETA	PHASE	SHEAR	PHASE	MOMENT	PHASE
1	1.3982E-01	1.8000E 02	2.7942E-02	1.8000E 02	6.4290E 01	1.8000E 02	0.0	0.0
2	1.1453E-01	1.8000E 02	2.7742E-02	1.8000E 02	1.9230E 02	1.8000E 02	5.7861E 01	0.0
3	8.6356E-02	1.8000E 02	2.6756E-02	1.8000E 02	2.8770E 02	1.8000E 02	2.5016E 02	0.0
4	5.9473E-02	1.8000E 02	2.4233E-02	1.8000E 02	3.5417E 02	1.8000E 02	5.3786E 02	0.0
5	3.5819E-02	1.8000E 02	1.9655E-02	1.8000E 02	3.9308E 02	1.8000E 02	8.9202E 02	0.0
6	1.7751E-02	1.8000E 02	1.2684E-02	1.8000E 02	4.1292E 02	1.8000E 02	1.2851E 03	0.0
7	8.9561E-03	1.8000E 02	5.1256E-03	1.8000E 02	4.1605E 02	1.8000E 02	1.6206E 03	0.0
8	4.1289E-03	1.8000E 02	4.0837E-03	1.8000E 02	4.2106E 02	1.8000E 02	2.0366E 03	0.0
9	2.4824E-05	1.8000E 02	2.5906E-03	1.8000E 02	1.1022E 02	0.0	1.8939E 03	0.0
10	2.9194E-03	0.0	6.5375E-04	1.8000E 02	1.1642E 02	0.0	1.6845E 03	0.0
11	2.2824E-03	0.0	1.1331E-03	0.0	1.1613E 03	0.0	1.4517E 03	0.0
12	5.4272E-05	0.0	1.3816E-03	0.0	2.6398E-06	0.0	6.7926E-08	0.0

STATION	BRGV	PHASE	BRGM	PHASE	AVGP
9	5.3124E 02	1.8000E 02	6.2694E 02	1.8000E 02	0.0
12	1.1614E 03	0.0	0.0	0.0	0.0

STATION	ZK	PHASE	ZT	PHASE	ZKT	PHASE	ZTK	PHASE
9	2.1400E 07	0.0	2.4200E 05	0.0	0.0	0.0	0.0	0.0
12	2.1400E 07	0.0	0.0	0.0	0.0	0.0	0.0	0.0

SEARCHING COMPLETED FROM 0.0 TO 6.2832E 03 RAD/SEC

100.0 cps

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V.M. CYROGENIC ENGINE - COLO END SHELL FREQUENCY

MIKE MORIMOTO JAN 74

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OF CALIFORNIA

VIB%RPM<	VIB%CPSC<	VIB%RAD/SC<	8YSRPM	AXIAL P	SHAFT/WHIRL RATIO			
67137.5	1118.96	7030.63	0.0	0.0	1.000	1		
STATION	ABSV	PHASE	THETA	PHASE	SHEAR	PHASE	MOMENT	PHASE
1	2.7932E 00	1.8000E 02	1.8017E 00	1.8000E 02	2.7889E 04	1.8000E 02	0.0	0.0
2	1.1108E 00	1.8000E 02	1.7148E 00	1.8000E 02	5.4665E 04	1.8000E 02	2.5100E 04	0.0
3	7.0014E-01	0.0	1.3791E 00	1.8000E 02	3.7765E 04	1.8000E 02	7.9766E 04	0.0
4	1.9458E 00	0.0	7.4740E-01	1.8000E 02	9.1377E 03	0.0	1.1753E 05	0.0
5	2.2874E 00	0.0	2.4078E-02	1.8000E 02	6.4298E 04	0.0	1.0839E 05	0.0
6	1.7568E 00	0.0	4.6413E-01	0.0	1.0665E 05	0.0	4.4094E 04	0.0
7	9.7531E-01	0.0	4.6813E-01	0.0	1.1399E 05	0.0	4.2556E 04	1.8000E 02
8	4.7458E-01	0.0	4.1141E-01	0.0	1.2642E 05	0.0	1.5655E 05	1.8000E 02
9	7.8513E-03	0.0	2.6121E-01	0.0	4.1568E 04	1.8000E 02	2.3672E 05	1.8000E 02
10	2.3153E-01	1.8000E 02	4.5530E-02	0.0	5.2180E 04	1.8000E 02	1.5974E 05	1.8000E 02
11	1.2934E-01	1.8000E 02	7.7041E-02	1.8000E 02	4.4308E 04	1.8000E 02	5.5385E 04	1.8000E 02
12	2.0739E-03	1.8000E 02	8.6520E-02	1.8000E 02	3.6822E-04	1.8000E 02	1.0279E-05	1.8000E 02
STATION	BRGV	PHASE	BRGM	PHASE	AVGP			
9	1.6802E 05	0.0	6.3212E 04	0.0	0.0			
12	4.4381E 04	1.8000E 02	0.0	0.0	0.0			
STATION	ZK	PHASE	ZT	PHASE	ZKT	PHASE	ZTK	PHASE
9	2.1400E 07	0.0	2.4200E 05	0.0	0.0	0.0	0.0	0.0
12	2.1400E 07	0.0	0.0	0.0	0.0	0.0	0.0	0.0

SEARCHING COMPLETED FROM 5.6549E 03 TO 1.1938E 04 RAD/SEC

1900. cps

ORIGINAL PAGE IS
OF POOR QUALITY

DATE 21 JAN 74
PART NO. 852600
PREPARED BY M. P. 119070

CALC. NO. C6263 SHEET NO. 8-51
MODEL NO. 1/4 W. V. M.
CHECKED BY _____

8.3.2 DEFLECTION DUE TO VIBRATION LOADING

RANDOM VIBRATION LOAD

$$f = 241 \text{ cps}$$

$$T = 10.0 \text{ (ASSUMED)}$$

$$PSD = 0.036 \text{ g}^2/\text{cps} \text{ (REF. SECTION 3)}$$

ONE SIGMA RESPONSE

$$\begin{aligned}\ddot{X}_1 &= \left(\pi \times 0.036 \times 10.0 \times 241 \right)^{1/2} \\ &= \underline{\underline{11.7 \text{ g's}}}\end{aligned}$$

3 SIGMA RESPONSE

$$\ddot{X}_3 = \underline{\underline{35.0 \text{ g's}}}$$

SINUSOIDAL VIBRATION

THE SINUSOIDAL VIBRATION INPUT AT 241 CPS IS 2.3 G'S (REF. SECTION 3). ASSUMING AN AMPLIFICATION FACTOR OF 10., THE SINUSOIDAL VIBRATION LOAD BECOMES 23. G'S.

∴ THE RANDOM VIBRATION LOADING IS MORE SEVERE.

ORIGINAL PAGE IS
OF POOR QUALITY



DATE 10 JAN 74
 PART NO. 852600
 PREPARED BY MATUNGA

CALC. NO. C6264 SHEET NO. 8-52
 MODEL NO. 1/4 W. V.M.
 CHECKED BY _____

8.3.2 DEFLECTION DUE TO VIBRATION LOADING

THE DEFLECTION DUE TO VIBRATION LOADING WAS DETERMINED USING PROGRAM VOZ45 WITH THE INERTIA LOADS APPLIED AS STATIC LOADS AT EACH MASS STATION.

$$P_i = \text{LOAD APPLIED AT THE MASS STATIONS} = W_i \times L F = M_i \times g \times L F$$

<u>STATION</u>	<u>W_i</u>	<u>W_i × L F</u>
1	.0780	3.0576
2	.1882	7.3774
3	.1882	7.3774
4	.1882	7.3774
5	.1882	7.3774
6	.1882	7.3774
7	.0588	2.3050
8	.2045	8.0164
9	.0307	1.2034
10	.3579	14.0297
11	.8700	34.1040
12	.2766	10.8427

NOTE: THE ABOVE WERE BASED ON A 39.2 G ACCELERATION.
 SINCE THE LOAD IS 35.0 G'S, THE DEFLECTION FROM VOZ45 WILL BE CORRECTED BY MULTIPLYING BY $\frac{35.0}{39.2}$.

THE DEFLECTION FROM VOZ45 IS 0.00964 IN. (AT 39.2 G'S).

$$\text{AT } 35.0 \text{ G'S, } y = 0.00964 \times \frac{35.0}{39.2} = \underline{\underline{0.0086 \text{ IN.}}}$$



V.M. CYCLOENIC ENGINE - COLD END SHELL DEFLECTION DUE TO
RANDOM VIBRATION MIKE MORIMOTO JAN 74



GARRETT
AIRESEARCH MANUFACTURING COMPANY
OF CALIFORNIA

VIBXRPMS	VIBXCPS	VIBXRAD/SEC	SYSRPM	AXIAL P	SHAFT/WHIRL RATIO				
0.0	0.0	0.0	0.0	0.0	1.000				
STATION	ARVY	PHASE	THETA	SHEAR	MOMENT	ZK	REZK	TM7K	ZT
1	9.6426E-03	0.0	1.8613E-03	3.0576E 00	0.0	0.0	0.0	0.0	0.0
2	7.9608E-03	0.0	1.8518E-03	1.0435E 01	2.7518E 00	0.0	0.0	0.0	0.0
3	6.0841E-03	0.0	1.8007E-03	1.7812E 01	1.3187E 01	0.0	0.0	0.0	0.0
4	4.2681E-03	0.0	1.6593E-03	2.5190E 01	3.0999E 01	0.0	0.0	0.0	0.0
5	2.6248E-03	0.0	1.3801E-03	3.2567E 01	5.6189E 01	0.0	0.0	0.0	0.0
6	1.3214E-03	0.0	9.1605E-04	3.9945E 01	8.8756E 01	0.0	0.0	0.0	0.0
7	4.4816E-04	0.0	3.6986E-04	4.2250E 01	1.2121E 02	0.0	0.0	0.0	0.0
8	2.9625E-04	0.0	2.8876E-04	5.0266E 01	1.6346E 02	0.0	0.0	0.0	0.0
9	8.8559E-06	0.0	1.6272E-04	5.2449E 01	1.8189E 02	2.1400E 07	2.1400E 07	0.0	2.4200E 05
10	1.0286E-04	1.8000E 02	1.9760E-05	3.8420E 01	8.2234E 01	0.0	0.0	0.0	0.0
11	4.0419E-05	1.8000E 02	3.0166E-05	4.3158E 00	5.3947E 00	0.0	0.0	0.0	0.0
12	3.0501E-07	0.0	3.1090E-05	2.9802E-08	8.2946E-10	2.1400E 07	2.1400E 07	0.0	0.0

VIBXRPMS	VIBXCPS	VIBXRAD/SEC	SYSRPM	AXIAL P	SHAFT/WHIRL RATIO				
10.0	0.17	1.05	0.0	0.0	1.000				
STATION	ARVY	PHASE	THETA	SHEAR	MOMENT	ZK	REZK	TMZK	ZT
1	9.6426E-03	0.0	1.8613E-03	3.0576E 00	0.0	0.0	0.0	0.0	0.0
2	7.9608E-03	0.0	1.8518E-03	1.0435E 01	2.7518E 00	0.0	0.0	0.0	0.0
3	6.0841E-03	0.0	1.8007E-03	1.7812E 01	1.3187E 01	0.0	0.0	0.0	0.0
4	4.2681E-03	0.0	1.6593E-03	2.5190E 01	3.0999E 01	0.0	0.0	0.0	0.0
5	2.6248E-03	0.0	1.3801E-03	3.2567E 01	5.6189E 01	0.0	0.0	0.0	0.0
6	1.3214E-03	0.0	9.1605E-04	3.9945E 01	8.8756E 01	0.0	0.0	0.0	0.0
7	4.4816E-04	0.0	3.6986E-04	4.2250E 01	1.2121E 02	0.0	0.0	0.0	0.0
8	2.9625E-04	0.0	2.8876E-04	5.0266E 01	1.6346E 02	0.0	0.0	0.0	0.0
9	8.8559E-06	0.0	1.6272E-04	5.2450E 01	1.8189E 02	2.1400E 07	2.1400E 07	0.0	2.4200E 05
10	1.0286E-04	1.8000E 02	1.9760E-05	3.8420E 01	8.2234E 01	0.0	0.0	0.0	0.0
11	4.0419E-05	1.8000E 02	3.0166E-05	4.3154E 00	5.3943E 00	0.0	0.0	0.0	0.0
12	3.0501E-07	0.0	3.1099E-05	1.8254E-07	4.8458E-09	2.1400E 07	2.1400E 07	0.0	0.0

VIBXRPMS	VIBXCPS	VIBXRAD/SEC	SYSRPM	AXIAL P	SHAFT/WHIRL RATIO				
20.0	0.33	2.09	0.0	0.0	1.000				
STATION	ARVY	PHASE	THETA	SHEAR	MOMENT	ZK	REZK	TMZK	ZT
1	3.6426E-03	0.0	1.8613E-03	3.0576E 00	0.0	0.0	0.0	0.0	0.0
2	7.9608E-03	0.0	1.8518E-03	1.0435E 01	2.7518E 00	0.0	0.0	0.0	0.0
3	6.0841E-03	0.0	1.8007E-03	1.7812E 01	1.3187E 01	0.0	0.0	0.0	0.0
4	4.2681E-03	0.0	1.6593E-03	2.5190E 01	3.0999E 01	0.0	0.0	0.0	0.0
5	2.6248E-03	0.0	1.3801E-03	3.2567E 01	5.6189E 01	0.0	0.0	0.0	0.0
6	1.3214E-03	0.0	9.1605E-04	3.9945E 01	8.8756E 01	0.0	0.0	0.0	0.0
7	4.4816E-04	0.0	3.6986E-04	4.2250E 01	1.2121E 02	0.0	0.0	0.0	0.0
8	2.9625E-04	0.0	2.8876E-04	5.0266E 01	1.6346E 02	0.0	0.0	0.0	0.0
9	8.8559E-06	0.0	1.6272E-04	5.2450E 01	1.8189E 02	2.1400E 07	2.1400E 07	0.0	2.4200E 05
10	1.0286E-04	1.8000E 02	1.9760E-05	3.8420E 01	8.2234E 01	0.0	0.0	0.0	0.0
11	4.0417E-05	1.8000E 02	3.0166E-05	4.3144E 00	5.3930E 00	0.0	0.0	0.0	0.0
12	3.0506E-07	0.0	3.1089E-05	9.3132E-08	2.2555E-09	2.1400E 07	2.1400E 07	0.0	0.0

SEARCHING COMPLETED FROM 0.0 TO 2.6944E 00 RAD/SEC

ORIGINAL PAGE IS
OF POOR QUALITY

V.M. CRYOGENIC ENGINE - COLD END SHELL DEFLECTION DUE TO
RANDOM VIBRATION MIKE MORIMOTO JAN 74



GARRETT
AIRCRAFT MANUFACTURING COMPANY
OF CALIFORNIA

STATION	XFG	HA9S	IP	ID	F11R	F12R	F21R	F22R
1	4.0000E-01	2.0207E-04	0.0	0.0	0.0	0.0	0.0	0.0
2	1.5000E-00	4.8766E-04	0.0	0.0	-2.1815E-06	-4.4234E-06	-3.1162E-06	-4.3776E-06
3	2.5000E-00	4.8766E-04	0.0	0.0	-3.2288E-06	-3.2016E-06	-3.2016E-06	-6.4033E-06
4	3.5000E-00	4.8766E-04	0.0	0.0	-3.2288E-06	-3.2016E-06	-3.2016E-06	-6.4033E-06
5	4.5000E-00	4.8766E-04	0.0	0.0	-3.2288E-06	-3.2016E-06	-3.2016E-06	-6.4033E-06
6	5.5000E-00	4.8766E-04	0.0	0.0	-3.2288E-06	-3.2016E-06	-3.2016E-06	-6.4033E-06
7	6.3125E-00	1.5239E-04	0.0	0.0	-2.9181E-06	-2.1136E-06	-2.1136E-06	-5.2027E-06
8	7.3125E-00	5.2988E-04	0.0	0.0	-3.9232E-07	-2.8488E-07	-2.8488E-07	-5.6975E-07
9	8.4625E-00	7.9480E-05	0.0	0.0	-4.1595E-07	-3.7675E-07	-3.7675E-07	-6.5522E-07
10	1.0362E-01	9.2728E-04	0.0	0.0	-2.7451E-07	-1.0284E-06	-1.0284E-06	-1.0825E-06
11	1.2362E-01	2.2539E-03	0.0	0.0	-2.1489E-07	-1.1395E-06	-1.1395E-06	-1.1395E-06
12	1.3612E-01	7.1658E-04	0.0	0.0	-8.3152E-07	-2.1394E-07	-9.8353E-08	-2.4984E-07

STATION	VR	VI	MR	MI	F11I	F12I	F21I	F22I
1	3.0576E-00	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	7.3774E-00	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	7.3774E-00	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	7.3774E-00	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	7.3774E-00	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	7.3774E-00	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	2.3050E-00	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	8.0164E-00	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	1.2034E-00	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	1.4030E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	3.4104E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	1.0803E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0

STATION	DYR	DYT	DTHER	DTHEI	EYR	EYI	ETHER	ETHEI
1	0.0	0.0	0.0	0.0	1.0000E-03	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	1.0000E-03	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	1.0000E-03	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	2.0000E-01	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

ORIGINAL PAGE IS
OF POOR QUALITY

V.M. CYROGENIC ENGINE - COLO END SHELL DEFLECTION DUE TO
UNE G STATIC LOADS MIKE MORIMOTO JAN 74



AIRSEARCH MANUFACTURING COMPANY
OF CALIFORNIA

STATION	XCG	MASS	IP	ID	F11R	F12R	F21R	F22R
1	6.0000E-01	2.0207E-04	0.0	0.0	0.0	0.0	0.0	0.0
2	1.5000E-00	4.8766E-04	0.0	0.0	-2.1815E-06	-4.4236E-06	-3.1162E-06	8.3776E-06
3	2.5000E-00	4.8766E-04	0.0	0.0	-3.2288E-06	-3.2016E-06	-3.2016E-06	6.4033E-06
4	3.5000E-00	4.8766E-04	0.0	0.0	-3.2288E-06	-3.2016E-06	-3.2016E-06	6.4033E-06
5	4.5000E-00	4.8766E-04	0.0	0.0	-3.2288E-06	-3.2016E-06	-3.2016E-06	6.4033E-06
6	5.5000E-00	4.8766E-04	0.0	0.0	-3.2288E-06	-3.2016E-06	-3.2016E-06	6.4033E-06
7	6.3125E-00	1.5239E-04	0.0	0.0	-2.9181E-06	-2.1136E-06	-2.1136E-06	5.2027E-06
8	7.3125E-00	5.2988E-04	0.0	0.0	-3.9232E-07	-2.8488E-07	-2.8488E-07	5.6975E-07
9	8.4625E-00	7.9480E-05	0.0	0.0	-4.1595E-07	-3.7675E-07	-3.7675E-07	6.5522E-07
10	1.0362E-01	9.2728E-04	0.0	0.0	-2.7451E-07	-1.0284E-06	-1.0284E-06	1.0625E-06
11	1.2362E-01	2.2539E-03	0.0	0.0	-2.1489E-07	-1.1395E-06	-1.1395E-06	1.1395E-06
12	1.3612E-01	7.1658E-04	0.0	0.0	-4.3152E-07	-2.1394E-07	-9.8353E-08	2.4984E-07

STATION	VR	VI	MR	MI	F11I	F12I	F21I	F22I
1	7.8000E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	1.8820E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	1.8820E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	1.8820E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	1.8820E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	1.8820E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	5.8800E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	2.0450E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	3.0700E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	3.5790E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	8.7000E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	2.7660E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0

STATION	DYR	DYI	DYER	DYEI	EYR	EYI	ETHER	ETHEI
1	0.0	0.0	0.0	0.0	1.0000E-03	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	1.0000E-03	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	1.0000E-03	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	2.0000E-01	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

ORIGINAL PAGE IS
OF POOR QUALITY

V.M. CYROGENIC ENGINE - COLO END SHELL DEFLECTION DUE TO
ONE G STATIC LOADS MIKE MORIMOTO JAN 74



GARRETT
AIRCRAFT MANUFACTURING COMPANY
OF CALIFORNIA

VIBX RPM	VIBX CPS	VIBX RAD/SEC	SYS RPM	AXIAL P	SHAFT/WHIRL RATIO				
0.0	0.0	0.0	0.0	0.0	1.000				
STATION	ABSY	PHASE	THETA	SHEAR	MOMENT	ZK	REZK	IMZK	ZT
1	2.4599E-04	0.0	4.7482E-05	7.8000E-02	0.0	0.0	0.0	0.0	0.0
2	2.0308E-04	0.0	4.7239E-05	2.6620E-01	7.0200E-02	0.0	0.0	0.0	0.0
3	1.5521E-04	0.0	4.5937E-05	4.5440E-01	3.3640E-01	0.0	0.0	0.0	0.0
4	1.0888E-04	0.0	4.2328E-05	6.4260E-01	7.9080E-01	0.0	0.0	0.0	0.0
5	6.7010E-05	0.0	3.5207E-05	8.3080E-01	1.4334E-00	0.0	0.0	0.0	0.0
6	3.3710E-05	0.0	2.3369E-05	1.0190E-00	2.2642E-00	0.0	0.0	0.0	0.0
7	1.6535E-05	0.0	9.4352E-06	1.0778E-00	3.0921E-00	0.0	0.0	0.0	0.0
8	7.5576E-06	0.0	7.3664E-06	1.2823E-00	4.1699E-00	0.0	0.0	0.0	0.0
9	1.2398E-07	0.0	4.1511E-06	1.3380E-00	4.6400E-00	2.1400E 07	2.1400E 07	0.0	2.4200E 05
10	2.6240E-06	1.8000E 02	5.0409E-07	9.8010E-01	2.0978E-00	0.0	0.0	0.0	0.0
11	1.0311E-06	1.8000E 02	7.6956E-07	1.1010E-01	1.3762E-01	0.0	0.0	0.0	0.0
12	7.7804E-09	0.0	7.9311E-07	1.4988E-09	3.4561E-11	2.1400E 07	2.1400E 07	0.0	0.0

VIBX RPM	VIBX CPS	VIBX RAD/SEC	SYS RPM	AXIAL P	SHAFT/WHIRL RATIO				
10.0	0.17	1.05	0.0	0.0	1.000				
STATION	ABSY	PHASE	THETA	SHEAR	MOMENT	ZK	REZK	IMZK	ZT
1	2.4598E-04	0.0	4.7482E-05	7.8000E-02	0.0	0.0	0.0	0.0	0.0
2	2.0308E-04	0.0	4.7239E-05	2.6620E-01	7.0200E-02	0.0	0.0	0.0	0.0
3	1.5521E-04	0.0	4.5937E-05	4.5440E-01	3.3640E-01	0.0	0.0	0.0	0.0
4	1.0888E-04	0.0	4.2328E-05	6.4260E-01	7.9080E-01	0.0	0.0	0.0	0.0
5	6.7009E-05	0.0	3.5207E-05	8.3080E-01	1.4334E-00	0.0	0.0	0.0	0.0
6	3.3709E-05	0.0	2.3369E-05	1.0190E-00	2.2642E-00	0.0	0.0	0.0	0.0
7	1.6534E-05	0.0	9.4350E-06	1.0778E-00	3.0921E-00	0.0	0.0	0.0	0.0
8	7.5573E-06	0.0	7.3662E-06	1.2823E-00	4.1699E-00	0.0	0.0	0.0	0.0
9	1.2388E-07	0.0	4.1509E-06	1.3381E-00	4.6401E-00	2.1400E 07	2.1400E 07	0.0	2.4200E 05
10	2.6235E-06	1.8000E 02	5.0396E-07	9.8023E-01	2.0976E-00	0.0	0.0	0.0	0.0
11	1.0306E-06	1.8000E 02	7.6932E-07	1.0974E-01	1.3717E-01	0.0	0.0	0.0	0.0
12	7.7974E-09	0.0	7.9280E-07	1.8175E-08	4.6293E-10	2.1400E 07	2.1400E 07	0.0	0.0

VIBX RPM	VIBX CPS	VIBX RAD/SEC	SYS RPM	AXIAL P	SHAFT/WHIRL RATIO				
20.0	0.33	2.09	0.0	0.0	1.000				
STATION	ABSY	PHASE	THETA	SHEAR	MOMENT	ZK	REZK	IMZK	ZT
1	2.4598E-04	0.0	4.7481E-05	7.8001E-02	0.0	0.0	0.0	0.0	0.0
2	2.0308E-04	0.0	4.7238E-05	2.6620E-01	7.0201E-02	0.0	0.0	0.0	0.0
3	1.5520E-04	0.0	4.5937E-05	4.5440E-01	3.3640E-01	0.0	0.0	0.0	0.0
4	1.0888E-04	0.0	4.2328E-05	6.4260E-01	7.9081E-01	0.0	0.0	0.0	0.0
5	6.7007E-05	0.0	3.5207E-05	8.3081E-01	1.4334E-00	0.0	0.0	0.0	0.0
6	3.3707E-05	0.0	2.3368E-05	1.0190E-00	2.2642E-00	0.0	0.0	0.0	0.0
7	1.6533E-05	0.0	9.4344E-06	1.0778E-00	3.0922E-00	0.0	0.0	0.0	0.0
8	7.5567E-06	0.0	7.3656E-06	1.2823E-00	4.1700E-00	0.0	0.0	0.0	0.0
9	1.2390E-07	0.0	4.1502E-06	1.3385E-00	4.6403E-00	2.1400E 07	2.1400E 07	0.0	2.4200E 05
10	2.6221E-06	1.8000E 02	5.0357E-07	9.8062E-01	2.0971E-00	0.0	0.0	0.0	0.0
11	1.0284E-06	1.8000E 02	7.6862E-07	1.0865E-01	1.3581E-01	0.0	0.0	0.0	0.0
12	7.8482E-09	0.0	7.9186E-07	1.6880E-09	4.0927E-11	2.1400E 07	2.1400E 07	0.0	0.0

SEARCHING COMPLETED FROM 0.0 TO 2.0944E 00 RAD/SEC

V.H. CYROGENIC ENGINE - COLD END SHELL DEFLECTION DUE TO
ONE # AT TIP MIKE MORIMOTO JAN 74



GARRETT
AIRCRAFT MANUFACTURING COMPANY
OF CALIFORNIA

STATION	XCG	MASS	IP	ID	F11R	F12R	F21R	F22R
1	6.0000E-01	2.0207E-04	0.0	0.0	0.0	0.0	0.0	0.0
2	1.5000E 00	4.8766E-04	0.0	0.0	-2.1815E-06	-4.4236E-06	-3.1162E-06	8.3776E-06
3	2.5000E 00	4.8766E-04	0.0	0.0	-3.2288E-06	-3.2016E-06	-3.2016E-06	6.4033E-06
4	3.5000E 00	4.8766E-04	0.0	0.0	-3.2288E-06	-3.2016E-06	-3.2016E-06	6.4033E-06
5	4.5000E 00	4.8766E-04	0.0	0.0	-3.2288E-06	-3.2016E-06	-3.2016E-06	6.4033E-06
6	5.5000E 00	4.8766E-04	0.0	0.0	-3.2288E-06	-3.2016E-06	-3.2016E-06	6.4033E-06
7	6.3125E 00	1.5239E-04	0.0	0.0	-2.9181E-06	-2.1136E-06	-2.1136E-06	5.2027E-06
8	7.3125E 00	5.2988E-04	0.0	0.0	-3.9232E-07	-2.8488E-07	-2.8488E-07	5.6975E-07
9	8.4625E 00	7.9480E-05	0.0	0.0	-4.1595E-07	-3.7675E-07	-3.7675E-07	6.5522E-07
10	1.0362E 01	9.2728E-04	0.0	0.0	-2.7451E-07	-1.0284E-06	-1.0284E-06	1.0825E-06
11	1.2362E 01	2.2539E-03	0.0	0.0	-2.1489E-07	-1.1395E-06	-1.1395E-06	1.1395E-06
12	1.3612E 01	7.1658E-04	0.0	0.0	-4.3152E-07	-2.1394E-07	-9.8353E-08	2.4984E-07

STATION	VR	VI	MR	MT	F11I	F12I	F21I	F22I
1	1.0000E 00	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

STATION	DYR	DYI	DYER	DTHEI	EYR	EYI	ETHER	ETHEI
1	0.0	0.0	0.0	0.0	1.0000E-03	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	1.0000E-03	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	1.0000E-03	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	2.0000E-01	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

ORIGINAL PAGE IS
OF POOR QUALITY

V.M. CYROGENIC ENGINE - COLD END SHELL DEFLECTION DUE TO
ONE # AT TIP MIKE MORIMOTO JAN 74



GARRETT
AIRCRAFT MANUFACTURING COMPANY
OF CALIFORNIA

VIBX RPM< 0.0 VIBX CPS< 0.0 VIBX RAD/S< 0.0 SYS RPM 0.0 AXIAL P 0.0 SHAFT/WHIRL RATIO 1.000

STATION	ABSY	PHASE	THETA	SHEAR	MOMENT	ZK	REZK	IMZK	ZY
1	5.3248E-04	0.0	1.1998E-04	1.0000E 00	0.0	0.0	0.0	0.0	0.0
2	4.2231E-04	0.0	1.1687E-04	1.0000E 00	9.0000E-01	0.0	0.0	0.0	0.0
3	3.0509E-04	0.0	1.0790E-04	1.0000E 00	1.9000E 00	0.0	0.0	0.0	0.0
4	2.0005E-04	0.0	9.2534E-05	1.0000E 00	2.9000E 00	0.0	0.0	0.0	0.0
5	1.1357E-04	0.0	7.0763E-05	1.0000E 00	3.9000E 00	0.0	0.0	0.0	0.0
6	5.2062E-05	0.0	4.2589E-05	1.0000E 00	4.9000E 00	0.0	0.0	0.0	0.0
7	2.4897E-05	0.0	1.4982E-05	1.0000E 00	5.7125E 00	0.0	0.0	0.0	0.0
8	1.1150E-05	0.0	1.1443E-05	1.0000E 00	6.7125E 00	0.0	0.0	0.0	0.0
9	1.0342E-07	0.0	6.6680E-06	1.2134E 00	6.2488E 00	2.1400E 07	2.1400E 07	0.0	2.4200E 05
10	5.8063E-06	1.8000E 02	1.1512E-06	1.2134E 00	3.9434E 00	0.0	0.0	0.0	0.0
11	3.3540E-06	1.8000E 02	1.9597E-06	1.2134E 00	1.5167E 00	0.0	0.0	0.0	0.0
12	5.6699E-08	1.8000E 02	2.2193E-06	1.6997E-08	4.3201E-10	2.1400E 07	2.1400E 07	0.0	0.0

VIBX RPM< 10.0 VIBX CPS< 0.17 VIBX RAD/S< 1.05 SYS RPM 0.0 AXIAL P 0.0 SHAFT/WHIRL RATIO 1.000

STATION	ABSY	PHASE	THETA	SHEAR	MOMENT	ZK	REZK	IMZK	ZY
1	5.3247E-04	0.0	1.1998E-04	1.0000E 00	0.0	0.0	0.0	0.0	0.0
2	4.2231E-04	0.0	1.1687E-04	1.0000E 00	9.0000E-01	0.0	0.0	0.0	0.0
3	3.0509E-04	0.0	1.0790E-04	1.0000E 00	1.9000E 00	0.0	0.0	0.0	0.0
4	2.0005E-04	0.0	9.2534E-05	1.0000E 00	2.9000E 00	0.0	0.0	0.0	0.0
5	1.1357E-04	0.0	7.0763E-05	1.0000E 00	3.9000E 00	0.0	0.0	0.0	0.0
6	5.2062E-05	0.0	4.2589E-05	1.0000E 00	4.9000E 00	0.0	0.0	0.0	0.0
7	2.4897E-05	0.0	1.4982E-05	1.0000E 00	5.7125E 00	0.0	0.0	0.0	0.0
8	1.1150E-05	0.0	1.1443E-05	1.0000E 00	6.7125E 00	0.0	0.0	0.0	0.0
9	1.0343E-07	0.0	6.6678E-06	1.2135E 00	6.2489E 00	2.1400E 07	2.1400E 07	0.0	2.4200E 05
10	5.8058E-06	1.8000E 02	1.1511E-06	1.2135E 00	3.9433E 00	0.0	0.0	0.0	0.0
11	3.3539E-06	1.8000E 02	1.9595E-06	1.2130E 00	1.5163E 00	0.0	0.0	0.0	0.0
12	5.6682E-08	1.8000E 02	2.2190E-06	3.9581E-09	1.0550E-10	2.1400E 07	2.1400E 07	0.0	0.0

VIBX RPM< 20.0 VIBX CPS< 0.33 VIBX RAD/S< 2.09 SYS RPM 0.0 AXIAL P 0.0 SHAFT/WHIRL RATIO 1.000

STATION	ABSY	PHASE	THETA	SHEAR	MOMENT	ZK	REZK	IMZK	ZY
1	5.3247E-04	0.0	1.1998E-04	1.0000E 00	0.0	0.0	0.0	0.0	0.0
2	4.2230E-04	0.0	1.1687E-04	1.0000E 00	9.0000E-01	0.0	0.0	0.0	0.0
3	3.0509E-04	0.0	1.0790E-04	1.0000E 00	1.9000E 00	0.0	0.0	0.0	0.0
4	2.0004E-04	0.0	9.2534E-05	1.0000E 00	2.9000E 00	0.0	0.0	0.0	0.0
5	1.1357E-04	0.0	7.0763E-05	1.0000E 00	3.9000E 00	0.0	0.0	0.0	0.0
6	5.2060E-05	0.0	4.2588E-05	1.0000E 00	4.9000E 00	0.0	0.0	0.0	0.0
7	2.4895E-05	0.0	1.4982E-05	1.0000E 00	5.7125E 00	0.0	0.0	0.0	0.0
8	1.1149E-05	0.0	1.1442E-05	1.0000E 00	6.7125E 00	0.0	0.0	0.0	0.0
9	1.0345E-07	0.0	6.6672E-06	1.2139E 00	6.2491E 00	2.1400E 07	2.1400E 07	0.0	2.4200E 05
10	5.8043E-06	1.8000E 02	1.1507E-06	1.2139E 00	3.9427E 00	0.0	0.0	0.0	0.0
11	3.3522E-06	1.8000E 02	1.9588E-06	1.2119E 00	1.5149E 00	0.0	0.0	0.0	0.0
12	5.6632E-08	1.8000E 02	2.2181E-06	1.8626E-09	4.2746E-11	2.1400E 07	2.1400E 07	0.0	0.0

SEARCHING COMPLETED FROM 0.0 TO 2.0944E 00 RAD/SEC

ORIGINAL PAGE IS
OF POOR QUALITY

DATE 1/20/73
 PART NO. 852600
 PREPARED BY MR. HASTO

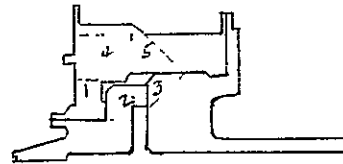
CALC. NO. C6263 SHEET NO. 8-53
 MODEL NO. 1/4 W VM
 CHECKED BY _____

8.4 COLD END FLANGE ASSY

NUT PRELOAD

JOINT FLEXIBILITY

ORIGINAL PAGE IS
 OF POOR QUALITY



ITEM	O.D.	I.D.	L	A	S = YAE	
1	1.92	1.45	.190	1.244	5.267×10^{-9}	1.219×10^{-8}
2	1.92	1.45	.250	1.244	6.930×10^{-9}	
3	1.93	1.45	.200	1.274	5.412×10^{-9}	
4	2.42	1.92	.300	1.704	6.070×10^{-9}	
5	2.42	2.01	.250	1.423	6.057×10^{-9}	
						2.974×10^{-8}

$$\frac{\Delta P_{NUT}}{P_{APPLIED}} = \frac{S_1 + S_2}{\Sigma S} = \frac{1.220 \times 10^{-8}}{2.974 \times 10^{-8}} = .410$$

$$\Delta P_{NUT} = .410 P_{APPLIED}$$

$$P_{NUT} = P_{PRELOAD} + .410 P_{APPLIED}$$



ORIGINAL PAGE IS
OF POOR QUALITY

DATE 17 DEC 73
PART NO. 852 600
PREPARED BY MORIMOTO

CALC. NO. C6263 SHEET NO. 8-60
MODEL NO. 1/4 W. V.M.
CHECKED BY _____

8.4 COLD END FLANGE ASSY

NUT PRE LOAD

$$\frac{F_A}{T} = \frac{2}{\left(\frac{1}{\sqrt{R}} - f_t \sin \lambda \right) \left(\frac{\tan \lambda}{\sqrt{R}} + f_t \cos \lambda \right) + \frac{f_n D_m}{\cos \xi}}$$

2.00 - 20 ← (N BUTT - 3 THREAD)

$D_p = \text{PITCH DIA.} = 2.00$

$\lambda = \text{HELIX ANGLE} = .05700, = 2.8648^\circ$

$\phi = \text{THREAD PRESSURE ANGLE} = 7.^\circ$

$R = 1 + \tan^2 \lambda + \tan^2 \phi = 1.01758$

$R'' = 1.00875$

$f_t = \text{THREAD FRICTION FACTOR} = .12$

$D_m = \text{MEAN CONTACT DIA. AT NUT FACE} = 1.605 \text{ IN.}$

$\xi = (180 - \text{COUNTERSINK ANGLE}) \div 2 = 0$

$f_n = \text{NUT FACE FRICTION FACTOR} = .12$

$F_A = 3.727 \quad T$

$T = 1 \text{ IN LB}$



DATE 19 DEC 73
PART NO. 852600
PREPARED BY MORIMOTO

CALC. NO. C6263 SHEET NO. 8-61
MODEL NO. 1/4 W. V.M.
CHECKED BY _____

8.4 COLD END FLANGE ASSY

NUT PRELOAD

APPLIED LOADS

CONSIDER SEAL O.D. AS PRESSURED AREA

SEAL: AP 20-1688-7-SP

OUTSIDE DIA. = 1.691

$$\begin{aligned} P_A &= \frac{\pi}{4} \times 1.691^2 \times 1250. = 2810. \text{ LBS AT OPERATING PRESSURE} \\ &= 2.246 \times 2080. = 4670. \text{ LBS. AT PROOF PRESSURE} \\ &= 2.246 \times 2800. = 6290. \text{ LBS AT BURST PRESSURE} \end{aligned}$$

FOR T = 65. FT-LBS = 780. IN-LBS. (MIN)

$$P_{\text{PRELOAD}} = 3.727 T = 2910. \text{ LBS.}$$

AT PROOF PRESSURE

$$P_{\text{NUT}} = \underline{4820. \text{ LBS.}}$$

AS SHOWN ON THE DIAGRAM (FOLLOWING PAGE), THE JOINT WILL NOT SEPARATE AT PROOF PRESSURE.

$$\underline{\text{USE: } T = 65. \text{ TO } 70. \text{ FT-LBS}}$$



DATE 18 DEC 73
PART NO. 852600
PREPARED BY MORIMOTO

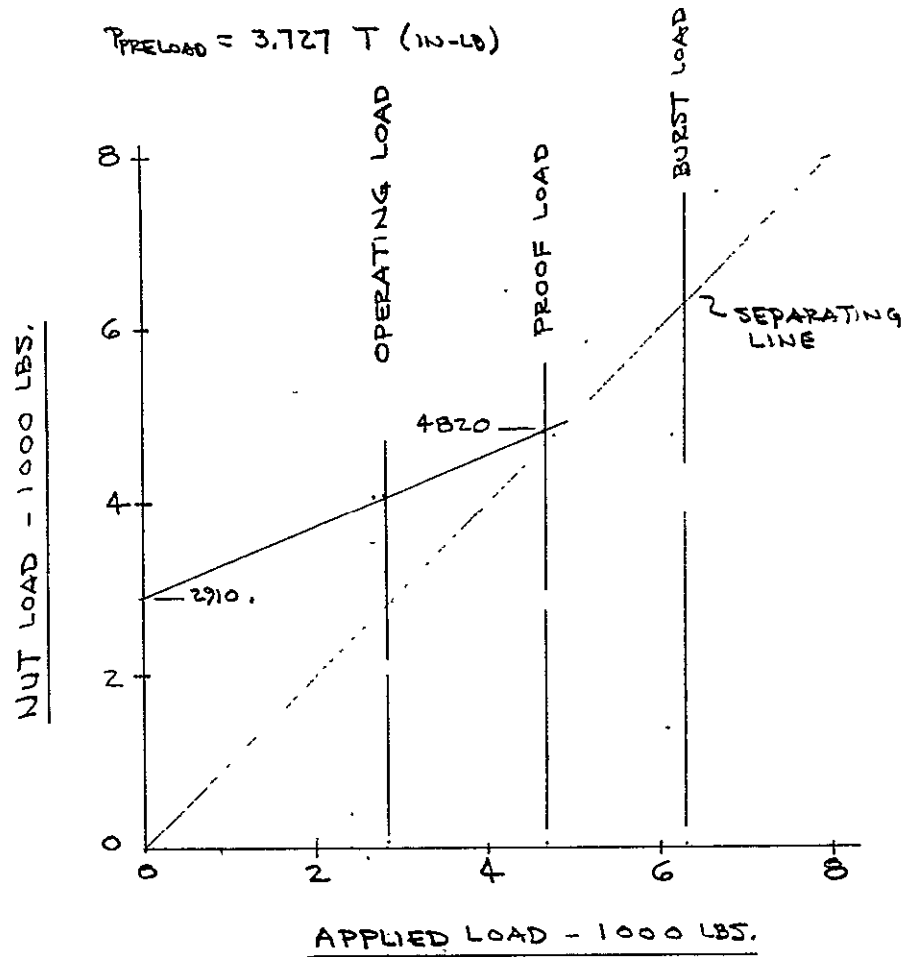
CALC. NO. C6263 SHEET NO. 8-62
MODEL NO. 1/4 W. V.M.
CHECKED BY _____

8.4 COLD END FLANGE ASSY

$$T = 65. \text{ FT-LBS. (MIN)}$$

$$P_{\text{NUT}} = P_{\text{PRELOAD}} + .410 P_{\text{APPLIED}}$$

$$P_{\text{PRELOAD}} = 3.727 T \text{ (IN-LB)}$$



DATE 19 DEC 73
PART NO. 852600
PREPARED BY MORIMOTO

CALC. NO. C6263 SHEET NO. 8-63
MODEL NO. 1/4 W. V.M.
CHECKED BY _____

8.4 COLD END FLANGE ASSY

THREAD SHEAR

SHEAR AREA OF EXTERNAL THREAD AT MINOR D/B. OF INTERNAL THD.

ASSUME $G = .0042$ (REF NBS HDBK #28)

$$D_o = \text{MAJOR D/B. OF EXT. THD} = \underline{1.996}$$

$$D_m = \text{MINOR D/B. OF INT. THD} = D_{\text{basic}} - 1.2p$$

$$= 2.000 - 1.2 \times .05 = \underline{1.940 \text{ IN.}}$$

THICKNESS AT .970 RADIUS

$$t = \frac{(D_o - D_m) \tan 7^\circ}{2} + F + \frac{(D_o - D_m) \tan 45^\circ}{2} \quad F = .16316p$$

$$= \frac{(1.996 - 1.940)}{2} \tan 7^\circ + .16316 \times .05 + .028 \tan 45^\circ$$

$$= .00344 + .00816 + .028 = .0396 \text{ IN.}$$

SHEAR AREA PER THREAD

$$A_s = .0396 \times \pi \times 1.940 = \underline{0.241 \text{ IN}^2}$$

NO. OF ENGAGED THREAD (MIN.)

$$N = .20 \times 20 = 4.$$

USE N=3. , 1ST THD CARRIES 50% OF LOAD

SHEAR STRESS AT BURST

$$f_s = \frac{.50 \times 6290.}{.241} = \underline{13,000 \text{ PSI}}$$

$$M.S. = \frac{180,000 \times .60}{13,000} - 1 =$$

HIGH



DATE 20 APR 73
 PART NO. 852545
 PREPARED BY M. G. MATO

CALC. NO. C 6263 SHEET NO. 8-64
 MODEL NO. 1/4 W V.M.
 CHECKED BY _____

8.5 COLD END VACUUM JACKET ASSY

COLLAPSE PRESSURE

ASSUMING EXTERNAL PRESSURE OF 15.9 PSI ACTS ON END AND
 RADIALY ON CYLINDRICAL PORTION.
 FROM REF. 5

$$P_{CR} = \frac{C_p D \pi^2}{R L^2}$$

$$\text{WHERE } D = \frac{E t^3}{12(1-\mu^2)}$$

$$= \frac{C_p E t^3 \pi^2}{12(1-\mu^2) R L^2}$$

C_p = PRESSURE PARAMETER
 WHICH IS A FUNCTION OF
 Z

$$Z = \left(\frac{L}{R} \right) \left(\frac{L}{t} \right) (1-\mu^2)^{1/4}$$

$$t_{min} = .012$$

$$D_i = 2.237 / 2.217$$

$$R_m = \frac{1}{2} (2.237 + .012) = 1.124$$

$$L = 5.600 \text{ IN.}$$

MAT'L : 304 CRES

$$E = 29.1 \times 10^6 \text{ PSI}, G = 12.5 \times 10^6, \mu = 0.16$$

$$Z = \left(\frac{5.600}{1.124} \right) \left(\frac{5.600}{.012} \right) (1-.16^2)^{1/4} = 2300.$$

$$C_p = 50, \text{ FROM FIG. 4, PG 126, REF 5}$$



DATE 20 APR 73
PART NO. 852545
PREPARED BY MORIMOTO

CALC. NO. c 6263 SHEET NO. 8-65
MODEL NO. 1/4 W.V.M.
CHECKED BY _____

8.5 COLD END VACUUM JACKET ASSY

COLLAPSING PRESSURE (CONT'D.)

$$P_{22} = \frac{50. \times 29 \times 10^6 \times .012^3 \times \pi^2}{12 (1-.16^2) \times 1.124 \times 5.60^{4/2}} = \underline{\underline{60.4 \text{ psi}}}$$

$$M.S. = \frac{60.0}{15.} - 1 =$$

3.00



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CALC. NO. C6263 SHEET NO. 266
 MODEL NO. 1/4 W.V.M.
 CHECKED BY _____

8.5 COLD END VACUUM JACKET

STRESS AT CYLINDER/RING JUNCTION

ASSUME RING IS RIGID.

$$M = .304 \text{ PR}t \quad (\text{REF. 4, PG 271})$$

$$R = 1.124$$

$$t = .012 \text{ (MIN.)}$$

$$f_b = \frac{6M}{t^2} = \frac{1.824 \text{ PR}}{t} = \frac{1.824 \times 15. \times 1.124}{.012} = 2,560. \text{ psi}$$

$$f_c = \frac{PR}{2t} = \frac{15 \times 1.124}{2 \times .012} = 704. \text{ psi}$$

$$f_b + f_c = 3,300. \text{ psi} \quad \text{- Low.}$$

COLLAPING PRESSURE - RAUGH CHECK USING REF. 4

$$L' = 4.70 R \left(\frac{R}{t} \right)^{1/2} = 4.70 \times 1.125 \left(\frac{1.125}{.012} \right)^{1/2} = 53.5$$

$$L = 6.$$

USE SHORT TUBE FORMULA ($L < L'$)

$$p' = \frac{.807 E t^3}{LR} \left[\left(\frac{1}{1-\mu^2} \right) \frac{t}{R} \right]^{3/4} = \frac{25,984 \times 10^6 t^3}{LR} \left(\frac{t}{R} \right)^{3/4}$$

$$= \frac{25,984 \times 10^6 \times .012^3}{6 \times 1.125} \left(\frac{.012}{1.125} \right)^{3/4} = 57.3 \text{ psi}$$

$$M.S. = \frac{57.3}{15.} - 1 =$$

2.82



SECTION 9
HOT-END DISPLACER
STRESS ANALYSIS

DATE 4 JAN 74
PART NO. 852574
PREPARED BY MORIMOTO

CALC. NO. C6263 SHEET NO. 9-1
MODEL NO. 1/4 W. V.M.
CHECKED BY _____

9. HOT END DISPLACER

9.1 TASK

9.2 BUCKLING ANALYSIS

9.3 SHELL ANALYSIS

9.4 BEARING JOURNAL DEFLECTION



DATE 4 JAN 74
PART NO. 852574
PREPARED BY MOTUMOTO

CALC. NO. C6263 SHEET NO. 9-2
MODEL NO. 1/4 W.V.M.
CHECKED BY _____

9.1 TASK

THE ANALYSIS OF THE HOT END DISPLACEMENT CONSISTS OF THE FOLLOWING TASKS:

- DETERMINE THE EXTERNAL COLLAPSING PRESSURE
- DETERMINE STRESSES DUE TO EXTERNAL PRESSURE AND TEMPERATURE GRADIENTS.
- DETERMINE BEARING JOURNAL DEFLECTION AND COMPARE TO CLEARANCE.



DATE 4-JAN-74
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CALC. NO. C6263 SHEET NO. 9-3
 MODEL NO. 4 W. V.M.
 CHECKED BY _____

9.2 BUCKLING ANALYSIS

THE METHOD DESCRIBED IN REF 5, PAGE 129, INVOLVES THE UTILIZATION OF A FAMILY OF CURVES RELATING Z AND C_p FOR VARIOUS VALUES OF F . THESE PARAMETERS ARE DEFINED AS:

$$F = \frac{12(1-\mu^2)}{L_f t^3} \left[I_f + A_f (e - \bar{z})^2 \right] + \frac{L_e}{L_f} \left(1 + 12 \frac{\bar{z}^2}{t^2} \right) - 1$$

WHERE: A_f = AREA OF RING

I_f = MOMENT OF INERTIA OF RING

e = DISTANCE FROM SHELL MID SURFACE TO CENTROID OF RING CROSS SECTION,

$\bar{z}$ = DISTANCE FROM SHELL MID SURFACE TO CENTROID OF COMBINED SECTION OF RING FRAME AND EFFECTIVE WIDTH OF SHEET,

L_f = RING SPACING

L_e = TOTAL EFFECTIVE WIDTH OF SHEET ASSUMED ACTING WITH THE RING,

$$C_p = \frac{p R L^2}{D \pi^2}$$

$$D = \frac{E t^3}{12(1-\mu^2)}$$

$$Z = \left(\frac{L}{R} \right) \left(\frac{L}{t} \right) (1-\mu^2)^{1/4}$$

t = THICKNESS OF CYLINDER
 L = OVERALL LENGTH OF CYL.
 R = MEAN CYLINDER RADIUS

THE COEFFICIENT C_p IS OBTAINED FROM CURVES RELATING C_p , Z , AND F ON PAGE 9-4.1.



DATE 4 JAN 74
 PART NO. 852574
 PREPARED BY MOSBY M. T.

CALC. NO. C6263 SHEET NO. 9-4
 MODEL NO. 1/4 W. V.M.
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9.2 BUCKLING ANALYSIS

$$L_f = 1.4375$$

$$L = 3.75$$

$$R = 1.125 - .020 = 1.105 \text{ in.}$$

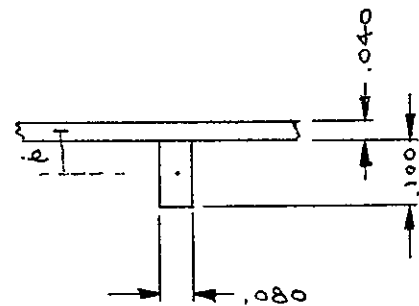
$$A_f = .080 \times .100 = .008 \text{ in}^2$$

$$I_f = \frac{.080 \times .100^3}{12} = 0.667 \times 10^{-5} \text{ in}^4$$

$$A_c = .040 \times 1.4375 = 0.0575 \text{ in}^2$$

$$\bar{e} = \frac{.020 \times .0575 + .090 \times .008}{.0575 + .008} - .020$$

$$= 0.00855 \text{ in.}$$



$$e = \frac{1}{2} (.040 + .100) = .070$$

$$F = \frac{12 \times .91}{1.4375 \times .040^3} \left(.667 \times 10^{-5} + .008 (.070 - .00855)^2 \right) + \left(1 + 12 \times \frac{.00855^2}{.040^2} \right) - 1$$

$$= 4.92$$

$$z = \frac{3.75^2 \times .91^{1/2}}{1.105 \times .040} = 3.04$$

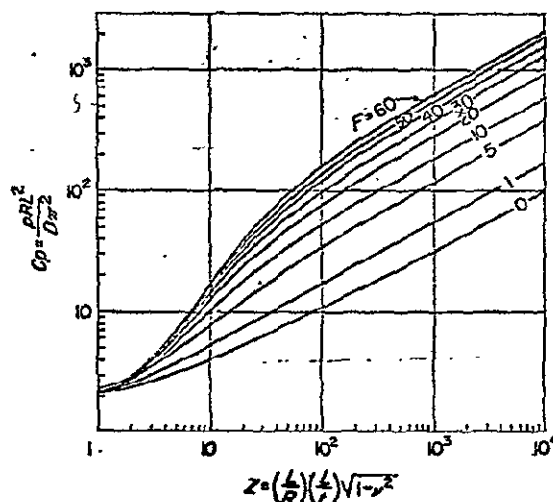


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CALC. NO. C6263 SHEET NO. 9-4.1
 MODEL NO. 1/4 W.V.M.
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7.2 BUCKLING ANALYSIS

THE CURVES RELATING C_p AND Z FOR VARIOUS VALUES OF F IS SHOWN BELOW. THESE CURVES WERE OBTAINED FROM REF (5).



FOR $Z = 304$ AND $F = 5$, $C_p = 60$.

$$\begin{aligned} P &= \frac{C_p E t^3 \pi^2}{12(1-\nu^2) R L^2} \\ &= \frac{60 \times 24.4 \times 10^6 \times .040^3 \times \pi^2}{12 \times .91 \times 1.105 \times 3.75^2} \\ &= \underline{5450. \text{ PSI}} \end{aligned}$$



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CALC. NO. C6263 SHEET NO. 9-5
MODEL NO. 1/4 W.V.M.
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9.2 BUCKLING ANALYSIS

AT MAX OPERATING PRESSURE,

$$M.S. = \frac{5450.}{1250.} - 1 =$$

3.36

AT PROOF PRESSURE,

$$M.S. = \frac{5450.}{2060.} - 1 =$$

1.65

AT BURST PRESSURE,

$$M.S. = \frac{5450.}{2800.} - 1 =$$

0.95



DATE 4 JAN 74
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CALC. NO. C-6263 SHEET NO. 9-6
MODEL NO. 1/4 W. V.M.
CHECKED BY _____

9.3 SHELL ANALYSIS

THE HOT END DISPLACER WAS ANALYZED USING A SHELL ANALYSIS PROGRAM DEVELOPED BY A. KALNINS. THE THEORETICAL BASIS FOR THIS SHELL ANALYSIS PROGRAM IS CONTAINED IN REF. (13).

THE SHELL ANALYSIS MODEL IS SHOWN ON THE NEXT PAGE.

THE DISPLACER WAS ANALYZED FOR 2800 PSI BURST PRESSURE WITH A TEMPERATURE GRADIENT ALONG THE DISPLACER CENTERLINE. THE MAX STRESSES WERE:

PART NO.	MAX. STRESS (KSI)	ALLOWABLE STRESS (KSI)	MARGIN OF SAFETY
2	129.	180	0.40
11	124.	140. ①	0.13
12	123.	140. ①	0.14
14	60.5	140. ①	1.31
	27. ②	35. ③	0.30

THE SHELL PROGRAM INPUT DATA ARE DERIVED ON PAGES 9-8 THRU 9-20. THE COMPUTER OUTPUT IS SHOWN ON PAGE 9-22 THRU 9-45.

THE STRESS FOR PART NO. 14 WAS COMPUTED MANUALLY ON PAGE 9-46. THE COMPUTER VALUE IS EXCESSIVELY HIGH BECAUSE THE LOCAL REINFORCEMENT WAS NOT INPUTED INTO THE COMPUTER.

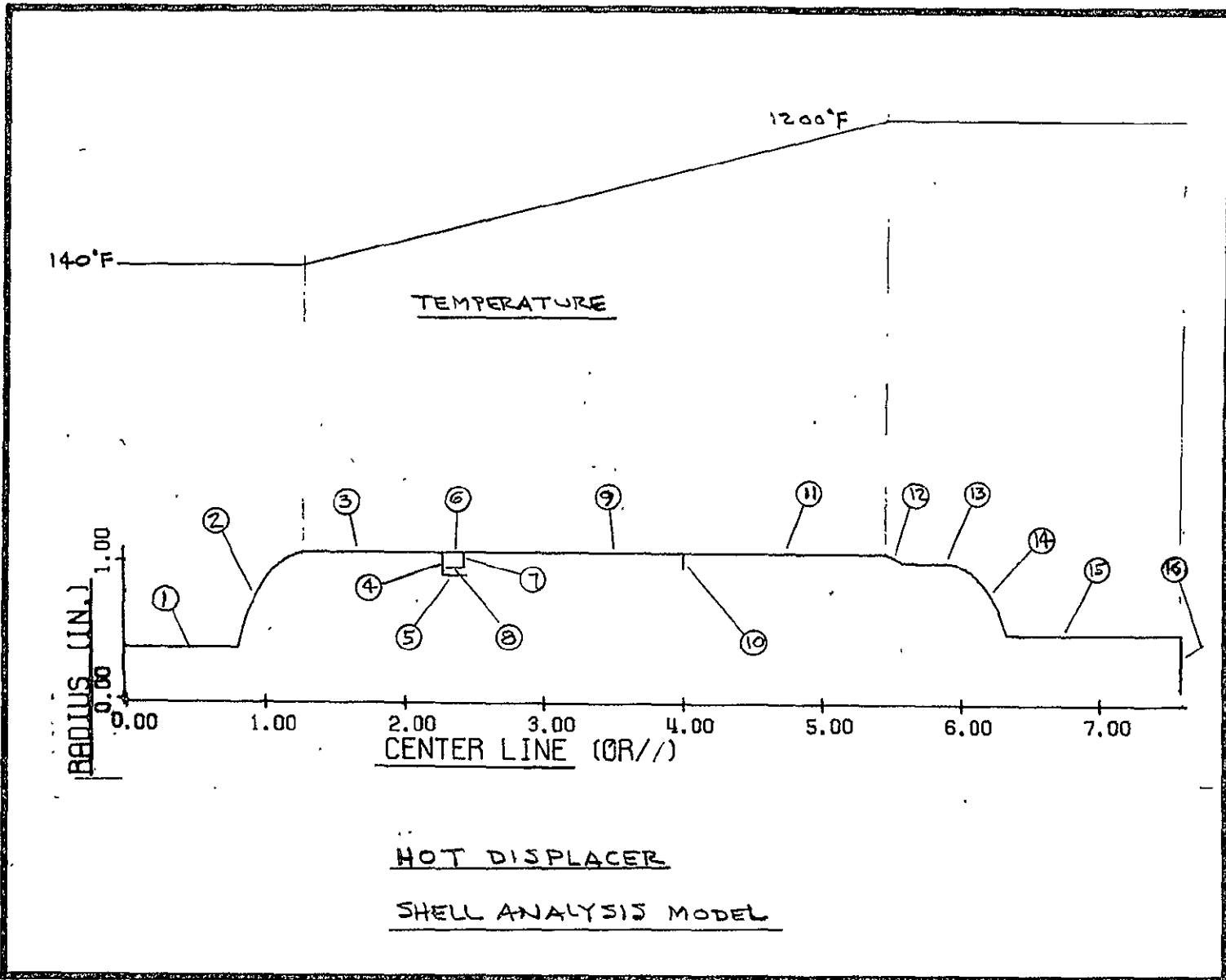
- NOTES: ① FTU AT 1200°F
② BASED ON 1250. PSI OPERATING PRESSURE
③ CREEP ALLOWABLE AT 1200°F; 0.2%; 20,000 HRS.





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74-9896-2
Page 9-8



DATE MAR 73
PART NO. 852574
PREPARED BY MAGNETA

CALC. NO. C6263 SHEET NO. 9-7
MODEL NO. 1/4 W.V.M.
CHECKED BY _____

DATE 13 Feb 73
 PART NO. 852574
 PREPARED BY MORIMOTO

CALC. NO. 66263 SHEET NO. 9-8
 MODEL NO. 1/4 W.V.M.
 CHECKED BY _____

9.3 SHELL ANALYSIS

INPUT DATA FOR SHELL PROGRAM

TEMPERATURE GRADIENT AND ELASTIC PROPERTIES

	DISTANCE ALONG E (IN)	TEMP. (°F)	E (10 ⁶ PSI)	ν	α (10 ⁻⁶ /F)
	0	—	29.8	0.300	7.6
	.798	—	29.8	0.300	7.6
	1.306	140.	29.8	0.300	7.6
4	2.266	378.	28.8	0.300	7.6
5, 6, 7, 8	3.841	744.	27.0	0.300	7.8
9	3.996	807.	27.0	0.300	7.8
11 & 12	5.576	1200.	24.4	0.300	8.4
13	5.878	1200.	24.4	0.300	8.4
14	6.325	1200.	24.4	0.300	8.4
15	7.625	1200.	24.4	0.300	8.4
16					



DATE 13 Feb 73
 PART NO. 852574
 PREPARED BY M. M. M. T. A.

CALC. NO. C6263 SHEET NO. 9-9
 MODEL NO. 1/4 W. V. M.
 CHECKED BY _____

9.3 SHELL ANALYSIS

INPUT DATA

PART NO. 1 CYLINDER (ISS=2)

$$SI = 0.0 \quad SX = 0.798 \quad R = 0.398 \quad \phi = 90^\circ \quad z = -1.102 + 1.111$$

$$T = 140^\circ F \quad E = 29.8 \times 10^6 \text{ PSI} \quad \alpha = 7.6 \times 10^{-6} \text{ in/in/}^\circ F$$

PART NO. 2 ELLIPSOID (REFERENCE SURFACE) y

$$A = \frac{1}{4} (2.2235 + 2.1415) = 1.091 \text{ in.}$$

$$B = \frac{1}{2} A = .5455 \text{ in.}$$

$$\frac{y}{a} + \frac{x}{b} = 1.$$

AT $y = 0.398 \text{ in.}$

$$x = b \left(1 - \frac{y}{a} \right) = .5455 \left(1 - \frac{.398}{1.091} \right) = 0.5079$$

$$\theta = \tan^{-1} \left[\frac{a}{b} \left(\frac{x}{(b^2 - x^2)^{1/2}} \right) \right] = \tan^{-1} \left[\frac{2 \times .5079}{(.5455^2 - .5079^2)^{1/2}} \right]$$

$$= \tan^{-1} (5.10452) = 78^\circ - 54.949' = 78.91572^\circ = 1.37734 \text{ RAD}$$

AT $y = 0.750 \text{ in.}$

$$x = .5455 \left(1 - \frac{.750}{1.091} \right) = .39616$$

$$\theta = \tan^{-1} \left[\frac{2 \times .39616}{(.5455^2 - .39616^2)^{1/2}} \right] = \tan^{-1} (2.1129)$$

$$= 64^\circ - 40.375' = 64.673^\circ = 1.12875 \text{ RAD}$$

ORIGINAL PAGE IS
OF POOR QUALITY



DATE 14 FEB 73
PART NO. 852574
PREPARED BY MORIMOTO

CALC. NO. C6263 SHEET NO. 9-10
MODEL NO. 1/4 W.V.M
CHECKED BY _____

9.3 SHELL ANALYSIS

INPUT DATA

PART NO. 2

THICKNESS

INSIDE ELLIPSE , A = 1.049 , B = .5245

AT Y = 0.398 ,

$$X = b \left(1 - \frac{y^2}{a^2} \right)^{1/2} = .5245 \left(1 - \frac{.398^2}{1.049^2} \right)^{1/2} = .48528$$

$$\begin{aligned} \Theta &= \tan^{-1} \left[\frac{a X}{b (b^2 - X^2)^{1/2}} \right] = \tan^{-1} \left[\frac{2 \times .48528}{(.5245^2 - .48528^2)^{1/2}} \right] \\ &= \tan^{-1} (4.8772) = 78^\circ - 24.71' = 78.413^\circ \end{aligned}$$

AT Y = 0.750 (GAGE POINT)

$$X = .5245 \left(1 - \frac{.750^2}{1.049^2} \right)^{1/2} = .36671$$

$$\begin{aligned} \Theta &= \tan^{-1} \left[\frac{a X}{b (b^2 - X^2)^{1/2}} \right] = \tan^{-1} \left[\frac{2 \times .36671}{(.5245^2 - .36671^2)^{1/2}} \right] \\ &= \tan^{-1} (1.9558) = 62^\circ - 55.14286' = 62.919^\circ \end{aligned}$$



DATE 14 Feb 73
PART NO. 852574
PREPARED BY MORIMOTO

CALC. NO. C6263 SHEET NO. 2-11
MODEL NO. 1/4 W.V.M.
CHECKED BY _____

9.3 SHELL ANALYSIS

INPUT DATA

PART NO. 2

THICKNESS

OUTSIDE ELLIPSE $A = 1.112$, $B = .5584$

AT $y = 0.398$.

$$X = b \left(1 - \frac{y^2}{a^2} \right)^{1/2} = .5584 \left(1 - \frac{.398^2}{1.112^2} \right)^{1/2} = 0.52141$$

$$\theta = \tan^{-1} \left[\frac{a X}{b (b^2 - X^2)^{1/2}} \right] = \tan^{-1} \left[\frac{2 \times .52141}{(.5584^2 - .52141^2)^{1/2}} \right]$$

$$= \tan^{-1} (5.2179) = 79^\circ - 9.060' = 79.151^\circ$$

AT $y = 0.750$ (GAGE POINT)

$$X = .5584 \left(1 - \frac{.750^2}{1.112^2} \right)^{1/2} = 0.41227$$

$$\theta = \tan^{-1} \left[\frac{2 \times .41227}{(.5584^2 - .41227^2)^{1/2}} \right] = \tan^{-1} (2.1893)$$

$$= 65^\circ - 27.059' = 65.451^\circ$$



DATE 14 FEB 73
PART NO. 852574
PREPARED BY M. ORYMA TO

CALC. NO. C6263 SHEET NO. 9-12
MODEL NO. 1/4 W.V.M.
CHECKED BY _____

9.3 SHELL ANALYSIS

INPUT DATA

PART NO. 2

Z - COORDINATES VS ϕ

AT $\phi = 0.19346$ RAD ($\gamma = 0.398$)

$$\begin{aligned} Z_1 &= - (X_m - X_c) \cos(90^\circ - \theta_m) \\ &= - (.50791 - .48528) (.98135) = -0.0222 \\ Z_2 &= (.52141 - .50791) (.98135) = 0.0132 \\ t &= 0.0354 \text{ IN.} \end{aligned}$$

AT $\phi = 0.44204$ ($\gamma = 0.750$)

$$\begin{aligned} Z_1 &= - (.39616 - .36671) (.90388) = -0.0266 \\ Z_2 &= (.41227 - .39616) (.90388) = 0.0146 \\ t &= 0.0412 \text{ IN.} \end{aligned}$$

AT $\phi = \pi/2 = 1.57080$ ($X=0, \gamma=A$)

$$\begin{aligned} Z_1 &= - (1.091 - 1.049) (1.00) = -0.042 \\ Z_2 &= (1.112 - 1.091) (1.00) = 0.021 \\ t &= 0.063 \text{ IN.} \end{aligned}$$

$T = 140^\circ\text{F}$



DATE 13 FEB 73
PART NO. 852574
PREPARED BY MORIMOTO

CALC. NO. C6263 SHEET NO. 9-13
MODEL NO. 1/4 W. V.M.
CHECKED BY _____

9.3 SHELL ANALYSIS

INPUT DATA

PART NO. 3 CYLINDER (ISS=8)

$$SI=0, SX=2.56-1.62+\frac{1}{2} \times .040 = 0.960 \text{ IN.}$$

$$R=\frac{1}{4}(2.2235+2.1415)=1.091 \quad \phi=90.1^\circ$$

$$t_{\text{NOM}} = 0.040 \text{ IN.} \quad 1/R_3 = 0.0$$

$$Z = -.020 \text{ TO } .020$$

$$\begin{array}{ll} TI = 140.1^\circ\text{F} & TX = 378.1^\circ\text{F} \\ \mu = 0.300 & \alpha = 7.6 \times 10^{-6} \\ EI = 29.8 & EX = 28.8 \end{array}$$

PART NO. 10 CONE (ISS=6)

$$SI=0, SX=1.091-\frac{1}{2} \times 1.944 = 0.119, \quad \phi=180.1^\circ$$

$$TI = 807.0^\circ\text{F}$$

$$E = 27.0 \times 10^6 \text{ PSI}, \quad \mu = 0.300, \quad \alpha = 7.8 \times 10^{-6}$$

$$A = -1.091$$

$$Z = -.020 \text{ TO } .020$$



DATE 14 Feb 73PART NO. 852574PREPARED BY MORIMOTOCALC. NO. C6263 SHEET NO. 9-14MODEL NO. 1/4 W. V. M.

CHECKED BY _____

9.3 SHELL ANALYSISINPUT DATAPART NO. 9 CYLINDER (ISS=8)

$$SI = 0, SX = 1.575, R = 1.091, \phi = 90^\circ$$

$$Z = -0.020 \text{ TO } 0.020$$

$$TI = 441.^\circ F, TX = 807.^\circ F$$

$$EI = 28.8 \times 10^6, EF = 27.0, \mu = 0.300$$

$$\alpha I = 7.8 \times 10^{-6}, \alpha F = 7.8 \times 10^{-6}$$

PART NO. 4 CONE (ISS=6)

$$SI = 0, SX = 1.091 - \left(\frac{1}{2} \times 1.9014 - 0.030 \right) = 0.170 \text{ in.}$$

$$\phi = 180^\circ, A = -1.091, Z = -0.025 \text{ TO } 0.025$$

$$T = 378.^\circ F, E = 28.8, \mu = 0.300, \alpha = 7.6$$

PART NO. 5 CYLINDER (ISS=2)

$$SI = 0, SX = 0.175, R = .921, \phi = 90^\circ$$

$$Z = -.015 \text{ TO } 0.015$$

$$T = 378.^\circ F$$

$$E = 28.8 \times 10^6 \text{ psi}, \mu = .300$$

$$\alpha = 7.6 \times 10^{-6} \text{ in/in/}^\circ F$$



DATE 15 Feb 73
PART NO. 852574
PREPARED BY M. M. M. M.

CALC. NO. 06263 SHEET NO. 9-15
MODEL NO. 1/4 W. V. M.
CHECKED BY _____

9.3 SHELL ANALYSIS

INPUT DATA

PART NO. 6 CYLINDER (ISS=2)

$$SI = 0, SX = 0.155, R = 1.091, \phi = 90.0^\circ$$

$$Z = -0.020 \text{ TO } 0.020$$

$$TI = 378^\circ\text{F}, TF = 441^\circ\text{F}, E = 28.8, \mu = 0.30, \alpha = 7.6$$

PART NO. 7 CONE (ISS=6)

$$SI = 0, SX = 1.091 - \frac{1}{2} \times 1.9019 + 0.023 = 0.117$$

$$A = -1.091, \phi = 180.0^\circ$$

$$Z = -0.020 \text{ TO } 0.020$$

$$T = 441^\circ\text{F} \quad E = 28.8 \times 10^6 \quad \alpha = 7.6 \times 10^{-6}$$

PART NO. 8 CYLINDER (ISS=2)

$$SI = 0, SX = 0.130, R = 0.974, \phi = 270.0^\circ$$

$$Z = -0.023 \text{ TO } 0.023$$

$$TI = 441^\circ\text{F} \quad E = 28.8 \times 10^6 \quad \alpha = 7.6 \times 10^{-6}$$

PART NO. 11 CYLINDER (ISS=8)

$$SI = 0, SX = 1.450, R = 1.091, \phi = 90.0^\circ, 1/R_1 = 0.$$

$$Z = -0.020 \text{ TO } 0.020$$

$$TI = 807^\circ\text{F}, TF = 1200^\circ\text{F}$$

$$EI = 27.0, EF = 24.4, \alpha I = 7.8, \alpha F = 8.4, \mu = 0.300$$



DATE 14 FEB 73
PART NO. 852574
PREPARED BY MORIMOTO

CALC. NO. C6263 SHEET NO. 9-16
MODEL NO. 1/4 in. V.M.
CHECKED BY _____

9.3 SHELL ANALYSIS

INPUT DATA

PART NO. 12 CONE (ISS = 6)

$$SI = 0.0, A = -(2.182^2 + 1.091^2)^{1/2} = -2.43955$$

$$SX = (.130^2 + .065^2)^{1/2} = .14534$$

$$\theta = \tan^{-1}(.065/.130) = 26.565^\circ$$

$$\phi = 90 + \theta = 116.565^\circ$$

$$Z_1 = -.020 \text{ TO } -.050 \quad Z_2 = .020 \text{ TO } .050$$

$$T = 1200.^\circ\text{F}, E = 24.4, \mu = 0.300, \alpha = 8.4 \times 10^{-6}$$

PART NO. 13 CYLINDER (ISS = 2)

$$SI = 0, SX = 0.302, R = 1.026, \phi = 90^\circ$$

$$Z = 0.0595 \text{ IN} \quad Z = -0.030 \text{ TO } 0.030$$

$$T = 1200^\circ\text{F}$$

$$L = \underbrace{2.3745 - 1.165}_{\text{SEE DWG.}} - .3280 - .095 = 0.302 \text{ IN.}$$

$$E = 24.4 \times 10^6 \quad \alpha = 8.4 \times 10^{-6}$$



DATE 14 FEB 73
PART NO. 852574
PREPARED BY MORIMOTO

CALC. NO. C6263 SHEET NO. 9-17
MODEL NO. 1/4 W.V.M.
CHECKED BY _____

9.3 SHELL ANALYSIS

INPUT DATA

PART NO. 14 ELLIPSOID

REFERENCE (SURFACE) ELLIPSE $A=1.026$, $B=.513$

AT $y = 0.504$

$$X = .513 \left(1 - \frac{.504^2}{1.026^2} \right)^{1/2} = 0.44684$$

$$\theta_1 = \tan^{-1} \left[\frac{2 \times .44684}{(.513^2 - .44684^2)^{1/2}} \right] = \tan^{-1} (3.5463)$$

$$= 74^\circ - 15.150' = 74.2525^\circ = 1.29595 \text{ RAD.}$$

$$\phi_1 = \pi/2 + \theta_1 = 2.86675 \text{ RAD.}$$

AT $y = 0.750$ (GAGE POINT)

$$X = .513 \left(1 - \frac{.750^2}{1.026^2} \right)^{1/2} = .35006$$

$$\theta_2 = \tan^{-1} \left[\frac{2 \times .35006}{(.513^2 - .35006^2)^{1/2}} \right] = \tan^{-1} (1.8670)$$

$$= 61^\circ - 49.530' = 61.82564^\circ = 1.07906 \text{ RAD.}$$

$$\phi_2 = \pi/2 + \theta_2 = 2.64986 \text{ RAD.}$$



DATE 14 Feb 73
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CALC. NO. C6263 SHEET NO. 9-12
 MODEL NO. 1/4 W.V.M.
 CHECKED BY _____

7.3 SHELL ANALYSIS

INPUT DATA

PART NO. 14

INSIDE ELLIPSE $A = .9968$ $B = .498$

AT $y = .504$

$$x = .498 \left(1 - \frac{.504^2}{.9968^2} \right)^{1/2} = .42965$$

$$\theta = \tan^{-1} \left[\frac{2 \times .42965}{(.498^2 - .42965^2)^{1/2}} \right] = \tan^{-1} (3.4127)$$

$$= 73^\circ - 40.083' = 73.668^\circ$$

AT $y = 0.750$

$$x = .32803 \text{ IN.}$$

$$\theta = \tan^{-1} (1.7509) = 60^\circ - 16.083' = 60.268^\circ$$

OUTSIDE ELLIPSE $A = 1.112$ $B = .5584$

AT $y = .504$

$$x = .5584 \left(1 - \frac{.504^2}{1.112^2} \right)^{1/2} = .49775$$

$$\theta = \tan^{-1} \left[\frac{2 \times .49775}{(.5584^2 - .49775^2)^{1/2}} \right] = 75^\circ - 44.145' = 75.726^\circ$$

3.9334
1.32184 RAD.

AT $y = .750$

$$x = 0.41227$$

$$\theta = 65.451^\circ$$

} SEE CALL, FOR PART NO. 2



DATE 14 Feb 73
PART NO. 852574
PREPARED BY Machimoto

CALC. NO. C6263 SHEET NO. 9-19
MODEL NO. 1/4 W.V.M.
CHECKED BY _____

9.3 SHELL ANALYSIS

INPUT DATA

PART NO. 14

Z COORDINATES VS. ϕ

AT $\phi = \pi/4 = 1.57080$ RAD ($X=0, Y=A$)

$$z_1 = - (1.026 - .9968) (1.00) = -0.0292$$

$$z_2 = (1.112 - 1.026) = 0.0860$$

$$t = -z_1 + z_2 = 0.115 \text{ IN.}$$

AT $\phi = 2.64986$ ($Y = .750$)

$$z_1 = - (.35006 - .32803) (.88152) = -0.0194$$

$$z_2 = (.41227 - .35006) (.88152) = 0.0548$$

$$t = 0.0742 \text{ IN.}$$

AT $\phi = 2.86675$ ($Y = .504$)

$$z_1 = - (.44684 - .42965) (.96246) = -0.0165$$

$$z_2 = (.49775 - .44684) (.96246) = 0.0490$$

$$t = -z_1 + z_2 = 0.0655 \text{ IN.}$$

$$T = 1200^\circ \text{F}$$

$$E = 24.4 \times 10^6$$

$$\alpha = 8.4 \times 10^{-6}$$



DATE 15 FEB 73
 PART NO. 852574
 PREPARED BY MORIMOTO

CALC. NO. C6263 SHEET NO. 9-20
 MODEL NO. 1/4 W.V.M.
 CHECKED BY _____

9.3 SHELL ANALYSIS

INPUT DATA

PART NO. 15 CYLINDER (ISS=2)

$$SI=0, SX=1.30$$

$$R = \frac{1}{2} (.6329 + .376) = .504, \phi = 90^\circ$$

$$t = 0.123 \text{ in.}$$

$$z = -.0615 \text{ to } .0615$$

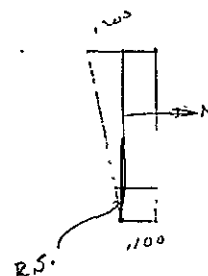
$$T = 1200^\circ\text{F}$$

PART NO. 16 CONE (ISS=6)

$$SI=0, SX=.404, A=-.504, \phi=180^\circ$$

$\frac{S}{O}$	$\frac{t}{.200}$	$\frac{z_1}{.100}$	$\frac{z_2}{.100}$
.404	.120	-.020	.100

$$T = 1200^\circ\text{F}$$



DATE 16 JAN 74
PART NO. 852574
PREPARED BY MORMOTO

CALC. NO. C6263 SHEET NO. 9-21
MODEL NO. 1/4 W.V.M.
CHECKED BY _____

9.3 SHELL ANALYSIS

THE SHELL PROGRAM SHOWED THE FOLLOWING MAX STRESSES
DUE TO 2800. PSI BURST PRESSURE PLUS TEMPERATURE LOADING.

PART NO.	MAX. STRESS (KSI)	ALLOW. STRESS (KSI)	M.S.
2	129.	180.	0.40
11	124.	140.*	0.13
12	123.	140.*	0.14
14	119.	140.*	0.18

* AT 1200. °F,

THE COMPUTER OUTPUT ARE INCLUDED AS PAGE 9-22
THRU 9-45.

THE STRESS AT THE JUNCTION OF PART 14 AND 15 AS
COMPUTED BY THE PROGRAM IS HIGHER THAN ACTUAL. THIS IS
BECAUSE THE LOCAL REINFORCEMENT WAS NOT INPUTED INTO
THE PROGRAM. THE STRESS IN THIS AREA WILL BE COMPUTED
MANUALLY.



KALNINS SHELL STRESS ANALYSIS..... HOT END DISPLACEN MORIMOTO MAR 73

STATIC ANALYSIS . PARTS=.16 BRANCHES= 3 NUMBER OF SUBCASES=. 1 .

ANGLES OF ROTATION OF BOUNDARY CONDITIONS ARE ALFL= -.00000 ALFRS= -.00000 -.00000 -.00000 -.00000

PART NO 1

SI= -.00000 SX= .79800+00 IPAR= 10 ING= 1 SHELL TYPE 2 NTP= 0 LAYERS MLY= 1

CYLINDRICAL SHELL NO 2 K= -.00000 R= .39800-00 PHI= 90.000 DEGREES

LAYER NO 1 FROM Z= -.10900+00 TO Z= .10900+00

CONSISTS OF ISOTROPIC MATERIAL: YOUNGS MODULUS E= .29800+08 POISSONS RATIO NU= .30000+00
COEFFICIENTS OF THERMAL EXPANSION AFI= .76000-05 ATHETA= .76000-05 MASS DENSITY RHO= -.00000

PART NO. 2

SI= .19350-00 SX= .15708+01 IPAR= 10 ING= 2 SHELL TYPE 5 NTP= 0 LAYERS MLY= 1

ELLIPSOIDAL SHELL NO 5 K= -.00000 A= .10910+01 B= .54550-00 DIRECTN= 1.

VARIABLE Z-COORDINATES OF THIS PART FOLLOW

ZI LINEAR FUNCTION GENERATOR NO. 1 FROM 3 POINTS

Y COORDINATES .2220+01 .2660+01 .4200+01

X COORDINATES .1935+00 .4420+00 .1571+01

ZO LINEAR FUNCTION GENERATOR NO. 2 FROM 3 POINTS

Y COORDINATES .1320+01 .1440+01 .2100+01

X COORDINATES .1935+00 .4420+00 .1571+01

LAYER NO 1 FROM Z= -.40000-01 TO Z= .40000+01

CONSISTS OF ISOTROPIC MATERIAL: YOUNGS MODULUS E= .29800+08 POISSONS RATIO NU= .30000+00
COEFFICIENTS OF THERMAL EXPANSION AFI= .76000-05 ATHETA= .76000-05 MASS DENSITY RHO= -.00000

PART NO 3

SI= -.00000 SX= .96000-00 IPAR= 10 ING= 1 SHELL TYPE 8 NTP= 0 LAYERS MLY= 1

GENERAL SHELL NO 8 K= -.00000 1/RFI= -.00000 R= .10910+01 FI= 90.000 DEG

VARIABLE ELASTIC PROPERTIES OF LAYER NO. 1 FOLLOW

EVAR LINEAR FUNCTION GENERATOR NO. 3 FROM 2 POINTS

Y COORDINATES .2980+08 .2880+08

X COORDINATES .0000 .9600-00

MU LINEAR FUNCTION GENERATOR NO. 4 FROM 2 POINTS

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Y COORDINATES .3000+00 .3000+00

X COORDINATES .0000 .9600+00

ALFA LINEAR FUNCTION GENERATOR NO. 5 FROM 2 POINTS

Y COORDINATES .7600+05 .7600+05

X COORDINATES .0000 .9600+00

LAYER NO 1 FROM Z= .20000+01 TO Z= .20000+01

CONSISTS OF ISOTROPIC MATERIAL, YOUNGS MODULUS E= .29800+08 POISSONS RATIO NU= .30000+00
COEFFICIENTS OF THERMAL EXPANSION AFI= .76000+05 ATHETA= .76000+05 MASS DENSITY RHO= .00000

PART NO 4

SI= .00000 SX= .17000+00 IPAR= 2 INC= 2 SHELL TYPE 6 NTP= 1 LAYERS MLY= 1

CONICAL SHELL NO 6 K= .00000 PHI= 180.000 DEGREES A= .10910+01

LAYER NO 1 FROM Z= .25000+01 TO Z= .25000+01

CONSISTS OF ISOTROPIC MATERIAL, YOUNGS MODULUS E= .28800+08 POISSONS RATIO NU= .30000+00
COEFFICIENTS OF THERMAL EXPANSION AFI= .76000+05 ATHETA= .76000+05 MASS DENSITY RHO= .00000

PART NO 5

SI= .00000 SX= .17500+00 IPAR= 2 INC= 2 SHELL TYPE 2 NTP= 2 LAYERS MLY= 1

CYLINDRICAL SHELL NO 2 K= .00000 R= .92100+00 PHI= 90.000 DEGREES

LAYER NO 1 FROM Z= .15000+01 TO Z= .15000+01

CONSISTS OF ISOTROPIC MATERIAL, YOUNGS MODULUS E= .28800+08 POISSONS RATIO NU= .30000+00
COEFFICIENTS OF THERMAL EXPANSION AFI= .76000+05 ATHETA= .76000+05 MASS DENSITY RHO= .00000

PART NO 6

SI= .00000 SX= .15500+00 IPAR= 4 INC= 2 SHELL TYPE 2 NTP= 0 LAYERS MLY= 1

CYLINDRICAL SHELL NO 2 K= .00000 R= .10910+01 PHI= 90.000 DEGREES

LAYER NO 1 FROM Z= .20000+01 TO Z= .20000+01

CONSISTS OF ISOTROPIC MATERIAL, YOUNGS MODULUS E= .28800+08 POISSONS RATIO NU= .30000+00
COEFFICIENTS OF THERMAL EXPANSION AFI= .76000+05 ATHETA= .76000+05 MASS DENSITY RHO= .00000

PART NO 7

SI= .00000 SX= .11700+00 IPAR= 2 INC= 2 SHELL TYPE 6 NTP= 1 LAYERS MLY= 1

CONICAL SHELL NO 6 K= .00000 PHI= 180.000 DEGREES A= .10910+01

LAYER NO 1 FROM Z= .20000+01 TO Z= .20000+01

CONSISTS OF ISOTROPIC MATERIAL, YOUNGS MODULUS E= .28800+08 POISSONS RATIO NU= .30000+00
COEFFICIENTS OF THERMAL EXPANSION AFI= .76000+05 ATHETA= .76000+05 MASS DENSITY RHO= .00000

PART NO 8



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GARRETT
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OF CALIFORNIA

SI= -.00000 SX= .13000-00 IPAR= 2 ING= 2 SHELL TYPE 2 NTP= 2 LAYERS MLV= 1

CYLINDRICAL SHELL NO 2 K= -.00000 R= .97400-00 PHI= 270.000 DEGREES

LAYER NO 1 FROM Z= -.23000-01 TO Z= .23000-01
CONSISTS OF ISOTROPIC MATERIAL, YOUNGS MODULUS E= .28800+08 POISSONS RATIO NU= .30000-00
COEFFICIENTS OF THERMAL EXPANSION AFI= .76000-05 ATHETA= .76000-05 MASS DENSITY RHO= -.00000

PART NO 9

SI= -.00000 SX= .15750+01 IPAR= 10 ING= 2 SHELL TYPE 8 NTP= 0 LAYERS MLV= 1

GENERAL SHELL NO 8 K= -.00000 1/RFI= -.00000 R= .10910+01 FI= 90.000 DEG

VARIABLE ELASTIC PROPERTIES OF LAYER NO. 1 FOLLOW

EVAR LINEAR FUNCTION GENERATOR NO. 6 FROM 2 POINTS

Y COORDINATES .2880+08 .2700+08

X COORDINATES .0000 .1575+01

MU LINEAR FUNCTION GENERATOR NO. 7 FROM 2 POINTS

Y COORDINATES .3000-00 .3000-00

X COORDINATES -.0000 .1575+01

ALFA LINEAR FUNCTION GENERATOR NO. 8 FROM 2 POINTS

Y COORDINATES .7600-05 .7800-05

X COORDINATES -.0000 .1575+01

LAYER NO 1 FROM Z= -.20000-01 TO Z= .20000-01
CONSISTS OF ISOTROPIC MATERIAL, YOUNGS MODULUS E= .28800+08 POISSONS RATIO NU= .30000-00
COEFFICIENTS OF THERMAL EXPANSION AFI= .76000-05 ATHETA= .76000-05 MASS DENSITY RHO= -.00000

PART NO 10

SI= -.00000 SX= .11900+00 IPAR= 2 ING= 2 SHELL TYPE 6 NTP= 2 LAYERS MLV= 1

CONICAL SHELL NO 6 K= -.00000 PHI= 180.000 DEGREES A= .10910+01

LAYER NO 1 FROM Z= -.40000-01 TO Z= .40000-01
CONSISTS OF ISOTROPIC MATERIAL, YOUNGS MODULUS E= .27000+08 POISSONS RATIO NU= .30000-00
COEFFICIENTS OF THERMAL EXPANSION AFI= .78000-05 ATHETA= .78000-05 MASS DENSITY RHO= -.00000

PART NO 11

SI= -.00000 SX= .14500+01 IPAR= 10 ING= 3 SHELL TYPE 8 NTP= 0 LAYERS MLV= 1

GENERAL SHELL NO 8 K= -.00000 1/RFI= -.00000 R= .10910+01 FI= 90.000 DEG

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VARIABLE ELASTIC PROPERTIES OF LAYER NO. 1 FOLLOW

EVAR LINEAR FUNCTION GENERATOR NO. 9 FROM 2 POINTS

Y COORDINATES .2700+08 .2440+08

X COORDINATES .0000 .1450+01

MU LINEAR FUNCTION GENERATOR NO. 10 FROM 2 POINTS

Y COORDINATES .3000+00 .3000+00

X COORDINATES .0000 .1450+01

ALFA LINEAR FUNCTION GENERATOR NO. 11 FROM 2 POINTS

Y COORDINATES .7800+05 .8400+05

X COORDINATES .0000 .1450+01

LAYER NO 1 FROM Z= .20000+01 TO Z= .20000+01

CONSISTS OF ISOTROPIC MATERIAL, YOUNGS MODULUS E= .27000+08 POISSONS RATIO NU= .30000+00
COEFFICIENTS OF THERMAL EXPANSION AFI= .78000+05 ATHETA= .78000+05 MASS DENSITY RHO= .00000

PART NO 12

SI= .00000 SX= .14534+00 IPAR= 5 INC= 1 SHELL TYPE 6 NTP= 0 LAYERS MLY= 1

CONICAL SHELL NO 6 K= .00000 PHI= 116.565 DEGREES A= .24396+01

VARIABLE Z=COORDINATES OF THIS PART FOLLOW

Z1 LINEAR FUNCTION GENERATOR NO. 12 FROM 2 POINTS

Y COORDINATES .2000+01 .5000+01

X COORDINATES .0000 .1453+00

Z0 LINEAR FUNCTION GENERATOR NO. 13 FROM 2 POINTS

Y COORDINATES .2000+01 .1000+00

X COORDINATES .0000 .1453+00

LAYER NO 1 FROM Z= .20000+01 TO Z= .10000+00

CONSISTS OF ISOTROPIC MATERIAL, YOUNGS MODULUS E= .24400+08 POISSONS RATIO NU= .30000+00
COEFFICIENTS OF THERMAL EXPANSION AFI= .84000+05 ATHETA= .84000+05 MASS DENSITY RHO= .00000

PART NO 13

SI= .00000 SX= .30200+00 IPAR= 6 INC= 3 SHELL TYPE 2 NTP= 0 LAYERS MLY= 1

CYLINDRICAL SHELL NO 2 K= .00000 R= .10260+01 PHI= 90.000 DEGREES

LAYER NO 1 FROM Z= .30000+01 TO Z= .30000+01

CONSISTS OF ISOTROPIC MATERIAL, YOUNGS MODULUS E= .24400+08 POISSONS RATIO NU= .30000+00
COEFFICIENTS OF THERMAL EXPANSION AFI= .84000+05 ATHETA= .84000+05 MASS DENSITY RHO= .00000



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PART NO 14

SI# .15708+01 SX# .28668+01 IPAR# 10 ING# 3 SHELL TYPE 5 NTP# 0 LAYERS HLY# 1
ELLIPSOIDAL SHELL NO 5 K# .00000 A# .10260+01 B# .51300+00 DIRECTN# 1.

VARIABLE Z-COORDINATES OF THIS PART FOLLOW

ZI LINEAR FUNCTION GENERATOR NO. 14 FROM 3 POINTS

Y COORDINATES .2920+01 .1940+01 .1650+01

X COORDINATES .1571+01 .2650+01 .2867+01

Z0 LINEAR FUNCTION GENERATOR NO. 15 FROM 3 POINTS

Y COORDINATES .8600+01 .5480+01 .4900+01

X COORDINATES .1571+01 .2650+01 .2867+01

LAYER NO 1 FROM Z# .40000+01 TO Z# .40000+01

CONSISTS OF ISOTROPIC MATERIAL; YOUNGS MODULUS E# .24400+08 POISSONS RATIO NU# .30000+00
COEFFICIENTS OF THERMAL EXPANSION AFI# .84000+05 ATHETA# .84000+05 MASS DENSITY RHO# .00000

PART NO 15

SI# .00000 SX# .13000+01 IPAR# 10 ING# 1 SHELL TYPE 2 NTP# 0 LAYERS HLY# 1

CYLINDRICAL SHELL NO. 2 K# .00000 R# .50400+00 PHI# 90.000 DEGREES

LAYER NO 1 FROM Z# .61500+01 TO Z# .61500+01

CONSISTS OF ISOTROPIC MATERIAL; YOUNGS MODULUS E# .24400+08 POISSONS RATIO NU# .30000+00
COEFFICIENTS OF THERMAL EXPANSION AFI# .84000+05 ATHETA# .84000+05 MASS DENSITY RHO# .00000

PART NO 16

SI# .00000 SX# .40400+00 IPAR# 3 ING# 2 SHELL TYPE 6 NTP# 0 LAYERS HLY# 1

CONICAL SHELL NO 6 K# .00000 PHI# 180.000 DEGREES A# .50400+00

VARIABLE Z-COORDINATES OF THIS PART FOLLOW

ZI LINEAR FUNCTION GENERATOR NO. 16 FROM 2 POINTS

Y COORDINATES .1000+00 .2000+01

X COORDINATES .0000 .4040+00

Z0 LINEAR FUNCTION GENERATOR NO. 17 FROM 2 POINTS

Y COORDINATES .1000+00 .1000+00

X COORDINATES .0000 .4040+00

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LAYER NO 1 FROM Z= .10000+00 TO Z= .10000+00
CONSISTS OF ISOTROPIC MATERIAL; YOUNGS MODULUS E= .24400+08 POISSONS RATIO NU= .50000-00
COEFFICIENTS OF THERMAL EXPANSION AFI= .84000-05 ATHETA= .84000-05 MASS DENSITY RHO= -.00000

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LNINS SHELL STRESS ANALYSIS....., HOT END DISPLACE. MORIMOTO MAR 73

SUBCASE NO 1 FOR FOURIER HARMONIC COS 0 THETA.

BOUNDARY CONDITIONS AT STARTING EDGE	1=	.00000	3=	.00000	5=	.00000	7=	.00000
BOUNDARY CONDITIONS AT FINAL EDGE	2=	.00000	4=	.00000	6=	.00000	8=	.00000
BOUNDARY CONDITION AT BRANCH EDGE NO 1	2=	.00000	4=	.00000	6=	.00000	7=	.00000
BOUNDARY CONDITION AT BRANCH EDGE NO 2	2=	.00000	4=	.00000	6=	.00000	7=	.00000
BOUNDARY CONDITION AT BRANCH EDGE NO 3	2=	.00000	4=	.00000	6=	.00000	7=	.00000

LOADS FOR PART NO 1 SUBCASE NO 1

RING LOADS AT END OF THIS PART ARE G= .00000 NPHI= .00000 MPHI= .00000 N= .00000
WK= .00000 UK= .00000 UTHK= .00000

SURFACE AND TEMP LOADS ARE P= .28000+04 PFI= .00000 PTHETA= .00000 TL= .14000+03 TU= .14000+03

LOADS FOR PART NO 2 SUBCASE NO 1

RING LOADS AT END OF THIS PART ARE G= .00000 NPHI= .00000 MPHI= .00000 N= .00000
WK= .00000 UK= .00000 UTHK= .00000

SURFACE AND TEMP LOADS ARE P= .28000+04 PFI= .00000 PTHETA= .00000 TL= .14000+03 TU= .14000+03

LOADS FOR PART NO 3 SUBCASE NO 1

RING LOADS AT END OF THIS PART ARE G= .00000 NPHI= .00000 MPHI= .00000 N= .00000
WK= .00000 UK= .00000 UTHK= .00000

SURFACE AND TEMP LOADS ARE P= .28000+04 PFI= .00000 PTHETA= .00000 TL= .14000+03 TU= .14000+03

CODE NUMBERS OF VARIABLE LOADS OVER THIS PART, GIVEN BY FGENS BELOW, ARE 4 5

TE13 LINEAR FUNCTION GENERATOR NO. 18 FROM 2 POINTS

Y COORDINATES .1400+03 .3780+03

X COORDINATES .0000 .9600+00

TE03 LINEAR FUNCTION GENERATOR NO. 19 FROM 2 POINTS

Y COORDINATES .1400+03 .3780+03

X COORDINATES .0000 .9600+00

LOADS FOR PART NO 4 SUBCASE NO 1

RING LOADS AT END OF THIS PART ARE G= .00000 NPHI= .00000 MPHI= .00000 N= .00000
WK= .00000 UK= .00000 UTHK= .00000

SURFACE AND TEMP LOADS ARE P= .00000 PFI= .00000 PTHETA= .00000 TL= .37800+03 TU= .37800+03

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LOADS FOR PART NO 5 SUBCASE NO 1

RING LOADS AT END OF THIS PART ARE $G = 0.00000$ $NPHI = 0.00000$ $MPHI = 0.00000$ $N = 0.00000$
 $WK = 0.00000$ $UK = 0.00000$ $UTHK = 0.00000$

SURFACE AND TEMP LOADS ARE $P = 0.00000$ $PFI = 0.00000$ $PTHETA = 0.00000$ $TL = 0.37800+03$ $TU = 0.37800+03$

LOADS FOR PART NO 6 SUBCASE NO 1

RING LOADS AT END OF THIS PART ARE $G = 0.00000$ $NPHI = 0.00000$ $MPHI = 0.00000$ $N = 0.00000$
 $WK = 0.00000$ $UK = 0.00000$ $UTHK = 0.00000$

SURFACE AND TEMP LOADS ARE $P = 0.28000+04$ $PFI = 0.00000$ $PTHETA = 0.00000$ $TL = 0.37800+03$ $TU = 0.44100+03$

CODE NUMBERS OF VARIABLE LOADS OVER THIS PART, GIVEN BY FGENS BELOW, ARE 4 5

TE16 LINEAR FUNCTION GENERATOR NO. 20 FROM 2 POINTS

Y COORDINATES $0.3780+03$ $0.4410+03$

X COORDINATES 0.0000 $0.1550+00$

TE06 LINEAR FUNCTION GENERATOR NO. 21 FROM 2 POINTS

Y COORDINATES $0.3780+03$ $0.4410+03$

X COORDINATES 0.0000 $0.1550+00$

LOADS FOR PART NO 7 SUBCASE NO 1

RING LOADS AT END OF THIS PART ARE $G = 0.00000$ $NPHI = 0.00000$ $MPHI = 0.00000$ $N = 0.00000$
 $WK = 0.00000$ $UK = 0.00000$ $UTHK = 0.00000$

SURFACE AND TEMP LOADS ARE $P = 0.00000$ $PFI = 0.00000$ $PTHETA = 0.00000$ $TL = 0.44100+03$ $TU = 0.44100+03$

LOADS FOR PART NO 8 SUBCASE NO 1

RING LOADS AT END OF THIS PART ARE $G = 0.00000$ $NPHI = 0.00000$ $MPHI = 0.00000$ $N = 0.00000$
 $WK = 0.00000$ $UK = 0.00000$ $UTHK = 0.00000$

SURFACE AND TEMP LOADS ARE $P = 0.00000$ $PFI = 0.00000$ $PTHETA = 0.00000$ $TL = 0.44100+03$ $TU = 0.44100+03$

LOADS FOR PART NO 9 SUBCASE NO 1

RING LOADS AT END OF THIS PART ARE $G = 0.00000$ $NPHI = 0.00000$ $MPHI = 0.00000$ $N = 0.00000$
 $WK = 0.00000$ $UK = 0.00000$ $UTHK = 0.00000$

SURFACE AND TEMP LOADS ARE $P = 0.28000+04$ $PFI = 0.00000$ $PTHETA = 0.00000$ $TL = 0.44100+03$ $TU = 0.80700+03$

CODE NUMBERS OF VARIABLE LOADS OVER THIS PART, GIVEN BY FGENS BELOW, ARE 4 5

TE19 LINEAR FUNCTION GENERATOR NO. 22 FROM 2 POINTS

Y COORDINATES $0.4410+03$ $0.8070+03$

X COORDINATES .0000 .1575+01

TE09 LINEAR FUNCTION GENERATOR NO. 23 FROM 2 POINTS

Y COORDINATES .4410+03 .8070+03

X COORDINATES .0000 .1575+01

LOADS FOR PART NO 10 SUBCASE NO 1

RING LOADS AT END OF THIS PART ARE G= .00000 NPHI= .00000 MPHI= .00000 N= .00000
WK= .00000 UK= .00000 UTHK= .00000

SURFACE AND TEMP LOADS ARE P= .00000 PFI= .00000 PTHETA= .00000 TL= .80700+03 TU= .80700+03

LOADS FOR PART NO 11 SUBCASE NO 1

RING LOADS AT END OF THIS PART ARE G= .00000 NPHI= .00000 MPHI= .00000 N= .00000
WK= .00000 UK= .00000 UTHK= .00000

SURFACE AND TEMP LOADS ARE P= .28000+04 PFI= .00000 PTHETA= .00000 TL= .80700+03 TU= .12000+04

CODE NUMBERS OF VARIABLE LOADS OVER THIS PART, GIVEN BY FGNS BELOW, ARE 4 5

TEI11 LINEAR FUNCTION GENERATOR NO. 24 FROM 2 POINTS

Y COORDINATES .8070+03 .1200+04

X COORDINATES .0000 .1450+01

TE011 LINEAR FUNCTION GENERATOR NO. 25 FROM 2 POINTS

Y COORDINATES .8070+03 .1200+04

X COORDINATES .0000 .1450+01

LOADS FOR PART NO 12 SUBCASE NO 1

RING LOADS AT END OF THIS PART ARE G= .00000 NPHI= .00000 MPHI= .00000 N= .00000
WK= .00000 UK= .00000 UTHK= .00000

SURFACE AND TEMP LOADS ARE P= .28000+04 PFI= .00000 PTHETA= .00000 TL= .12000+04 TU= .12000+04

LOADS FOR PART NO 13 SUBCASE NO 1

RING LOADS AT END OF THIS PART ARE G= .00000 NPHI= .00000 MPHI= .00000 N= .00000
WK= .00000 UK= .00000 UTHK= .00000

SURFACE AND TEMP LOADS ARE P= .28000+04 PFI= .00000 PTHETA= .00000 TL= .12000+04 TU= .12000+04

LOADS FOR PART NO 14 SUBCASE NO 1

RING LOADS AT END OF THIS PART ARE G= .00000 NPHI= .00000 MPHI= .00000 N= .00000
WK= .00000 UK= .00000 UTHK= .00000

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SURFACE AND TEMP LOADS ARE P= .28000+04 PFI= .00000 PTH A= .00000 TL= .12000+04 TU= .12000+04

LOADS FOR PART NO 15 SUBCASE NO 1

RING LOADS AT END OF THIS PART ARE Q= .00000 NPHI= .00000 MPHI= .00000 N= .00000
WK= .00000 UK= .00000 UTHK= .00000

SURFACE AND TEMP LOADS ARE P= .28000+04 PFI= .00000 PTHETA= .00000 TL= .12000+04 TU= .12000+04

LOADS FOR PART NO 16 SUBCASE NO 1

RING LOADS AT END OF THIS PART ARE Q= .00000 NPHI= .00000 MPHI= .00000 N= .00000
WK= .00000 UK= .00000 UTHK= .00000

SURFACE AND TEMP LOADS ARE P= .28000+04 PFI= .00000 PTHETA= .00000 TL= .12000+04 TU= .12000+04

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DEFLECTIONS AND STRESS RESULTANTS FOR WAVE NUMBER NX= 0 2800.PSI BURST PRESSURE PLUS TEMPERATURE LOADING

X	W	Q	UPHI	NPHI	BPHI	MPHI	UTHETA	N	NTHETA	MTHETA
MAIN SHELL PART NO. 1										
.0000	.00000	.37116+04	.00000	-.52182+03	.00000	-.43628+03	.00000	.00000	-.70687+04	-.15068+03
.0798	.38902-04	.25629+04	.10372+03	-.52182+03	-.85769-03	-.18679+03	.00000	.00000	-.64337+04	-.56057+02
.0798	.38902-04	.25629+04	.10372+03	-.52182+03	-.85769-03	-.18679+03	.00000	.00000	-.64337+04	-.56057+02
.1596	.12148-03	.16253+04	.20355-03	-.52182+03	-.11341-02	-.21456+02	.00000	.00000	-.50859+04	-.64367+01
.1596	.12147-03	.16255+04	.20355+03	-.52182+03	-.11340+02	-.21483+02	.00000	.00000	-.50861+04	-.64450+01
.2394	.21008-03	.97615+03	.29809-03	-.52182+03	-.10387-02	.80407+02	.00000	.00000	-.36397+04	.24122+02
.2394	.21006-03	.97614+03	.29809-03	-.52182+03	-.10387-02	.80387+02	.00000	.00000	-.36399+04	.24116+02
.3192	.28133-03	.59329+03	.38773-03	-.52182+03	-.71841-03	.14147+03	.00000	.00000	-.24767+04	.42440+02
.3192	.28131-03	.59324+03	.38773-03	-.52182+03	-.71846-03	.14145+03	.00000	.00000	-.24769+04	.42435+02
.3990	.32113-03	.39512+03	.47398-03	-.52182+03	-.26105-03	.18003+03	.00000	.00000	-.18271+04	.54008+02
.3990	.32112-03	.39505+03	.47398-03	-.52182+03	-.26109-03	.18002+03	.00000	.00000	-.18272+04	.54005+02
.4788	.32060-03	.26318+03	.55900-03	-.52182+03	.28660-03	.20629+03	.00000	.00000	-.18357+04	.61888+02
.4788	.32060-03	.26309+03	.55901-03	-.52182+03	.28652-03	.20629+03	.00000	.00000	-.18357+04	.61886+02
.5586	.27383-03	.55110+02	.64543-03	-.52182+03	.89207-03	.22000+03	.00000	.00000	-.25991+04	.66001+02
.5586	.27384-03	.55026+02	.64543-03	-.52182+03	.89198-03	.22000+03	.00000	.00000	-.25990+04	.65999+02
.6384	.17796-03	-.38617+03	.73615-03	-.52182+03	.15056-02	.20887+03	.00000	.00000	-.41639+04	.62662+02
.6384	.17798-03	-.38622+03	.73615-03	-.52182+03	.15055-02	.20887+03	.00000	.00000	-.41637+04	.62661+02
.7182	.35974-04	-.12187+04	.83405-03	-.52182+03	.20247-02	.14793+03	.00000	.00000	-.64815+04	.44378+02
.7182	.35995-04	-.12187+04	.83405-03	-.52182+03	.20246-02	.14793+03	.00000	.00000	-.64812+04	.44379+02
.7980	-.13772-03	-.25739+04	.94157-03	-.52182+03	.22594-02	.38325+00	.00000	.00000	-.93166+04	.11498+00
MAIN SHELL PART NO. 2										
.1935	-.95047+03	.17141+02	.45937+04	-.26262+04	.22593-02	.39952-00	.00000	.00000	-.23016+04	.75453+01
.2624	-.63481+03	.32233+02	.18617-04	-.25610+04	.65604-02	.49015+01	.00000	.00000	-.22653+04	.72845+01
.3312	.30072-03	.36933+02	-.92512-04	-.24839+04	-.10561-01	.86139+01	.00000	.00000	-.18512+04	.61714+01
.3312	.30098-03	.36935+02	-.92513+04	-.24839+04	-.10562-01	.86123+01	.00000	.00000	-.18511+04	.61699+01
.4001	.13447-02	.43492+02	-.21268-03	-.23780+04	-.11974-01	.11678+02	.00000	.00000	-.15231+04	.44781+01
.4690	.22800-02	.53561+02	-.38372-03	-.22594+04	-.11924-01	.14577+02	.00000	.00000	-.79485+03	.26175+01
.4690	.22801-02	.53560+02	-.38372-03	-.22594+04	-.11926-01	.14576+02	.00000	.00000	-.79481+03	.26168+01
.5378	.30284-02	.65386+02	-.59864-03	-.21424+04	-.10931-01	.17559+02	.00000	.00000	-.32426+03	.10105+01
.6067	.35744-02	.76385+02	-.84674-03	-.20355+04	-.93663-02	.20636+02	.00000	.00000	-.64194+02	-.18839+00
.6067	.35744-02	.76385+02	-.84674-03	-.20355+04	-.93666-02	.20636+02	.00000	.00000	-.64212+02	-.18863+00
.6756	.39341-02	.84310+02	-.11172-02	-.19426+04	-.75115-02	.23684+02	.00000	.00000	.36504+03	-.96641+00
.7444	.41351-02	.87543+02	-.14004-02	-.18645+04	-.55643-02	.26542+02	.00000	.00000	.58242+03	-.13679+01
.7444	.41351-02	.87540+02	-.14004-02	-.18645+04	-.55644-02	.26542+02	.00000	.00000	.58244+03	-.13681+01
.8133	.42068-02	.85095+02	-.16883-02	-.18003+04	-.36582-02	.29062+02	.00000	.00000	.72522+03	-.14624+01
.8821	.41753-02	.76494+02	-.19744-02	-.17483+04	-.18751-02	.31128+02	.00000	.00000	.80383+03	-.13223+01
.8821	.41753-02	.76487+02	-.19744-02	-.17483+04	-.18753-02	.31128+02	.00000	.00000	.80385+03	-.13225+01

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.9510	.40624-02	.61624+02	-.22534-02	-.17064+04	-.26064-03	.32656+02	.00000	.00000	.82858+03	-.16149+01
1.0199	.38852-02	.40646+02	-.25211-02	-.16727+04	.11654-02	.33591+02	.00000	.00000	.80872+03	-.59661-00
1.0199	.38852-02	.40643+02	-.25211-02	-.16727+04	.11653-02	.33591+02	.00000	.00000	.80872+03	-.59664-00
1.0887	.36573-02	.13859+02	-.27741-02	-.16454+04	.23981-02	.33891+02	.00000	.00000	.75223+03	-.11486+00
1.1576	.33889-02	-.18327+02	-.30096-02	-.16226+04	.34420-02	.33529+02	.00000	.00000	.66576+03	.39196-00
1.1576	.33889-02	-.18343+02	-.30096-02	-.16226+04	.34418-02	.33529+02	.00000	.00000	.66577+03	.39181-00
1.2265	.30882-02	-.55474+02	-.32254-02	-.16031+04	.43051-02	.32478+02	.00000	.00000	.55477+03	.89163-00
1.2953	.27616-02	-.97070+02	-.34198-02	-.15855+04	.49974-02	.30710+02	.00000	.00000	.42370+03	.13572+01
1.2953	.27616-02	-.97077+02	-.34198-02	-.15855+04	.49973-02	.30710+02	.00000	.00000	.42370+03	.13572+01
1.3642	.24143-02	-.14265+03	-.35911-02	-.15687+04	.55272-02	.26190+02	.00000	.00000	.27626+03	.17633+01
1.4331	.20505-02	-.19172+03	-.37383-02	-.15518+04	.59012-02	.24873+02	.00000	.00000	.11559+03	.20853+01
1.4331	.20505-02	-.19172+03	-.37383-02	-.15518+04	.59012-02	.24873+02	.00000	.00000	.11559+03	.20853+01
1.5019	.16741-02	-.24380+03	-.38604-02	-.15339+04	.61229-02	.20699+02	.00000	.00000	-.55472+02	.22965+01
1.5708	.12887-02	-.29842+03	-.39567-02	-.15144+04	.61919-02	.15592+02	.00000	.00000	-.23420+03	.23662+01

MAIN SHELL PART NO 3

.0000	.12888-02	-.29842+03	-.39567-02	-.15144+04	.61918-02	.15592+02	.00000	.00000	-.31456+03	.46777+01
.0960	.48746-03	-.10332+03	-.39477-02	-.15144+04	.88185-02	-.29144+01	.00000	.00000	-.14024+04	-.87432-00
.0960	.48746-03	-.10332+03	-.39477-02	-.15144+04	.88185-02	-.29144+01	.00000	.00000	-.14024+04	-.87432-00
.1920	-.22098-03	-.36534+01	-.38955-02	-.15144+04	.55426-02	-.73565+01	.00000	.00000	-.23822+04	-.22070+01
.1920	-.22098-03	-.36532+01	-.38955-02	-.15144+04	.55426-02	-.73566+01	.00000	.00000	-.23822+04	-.22070+01
.2880	-.56425-03	.27150+02	-.38070-02	-.15144+04	.17560-02	-.58228+01	.00000	.00000	-.29605+04	-.17468+01
.2880	-.56426-03	.27150+02	-.38070-02	-.15144+04	.17560-02	-.58228+01	.00000	.00000	-.29605+04	-.17468+01
.3840	-.60118-03	.22804+02	-.36916-02	-.15144+04	-.74718-03	-.32549+01	.00000	.00000	-.32045+04	-.97646-00
.3840	-.60119-03	.22804+02	-.36916-02	-.15144+04	-.74718-03	-.32549+01	.00000	.00000	-.32045+04	-.97646-00
.4800	-.45868-03	.64407+01	-.35557-02	-.15144+04	-.20886-02	-.18167+01	.00000	.00000	-.32540+04	-.54501-00
.4800	-.45867-03	.64449+01	-.35557-02	-.15144+04	-.20883-02	-.18170+01	.00000	.00000	-.32540+04	-.54511-00
.5760	-.21125-03	-.90485+01	-.34027-02	-.15144+04	-.30834-02	-.19862+01	.00000	.00000	-.31909+04	-.59587-00
.5760	-.21126-03	-.90447+01	-.34027-02	-.15144+04	-.30832-02	-.19862+01	.00000	.00000	-.31909+04	-.59585-00
.6720	.14819-03	-.14070+02	-.32356-02	-.15144+04	-.45238-02	-.32234+01	.00000	.00000	-.30085+04	-.96703-00
.6720	.14815-03	-.14069+02	-.32356-02	-.15144+04	-.45235-02	-.32232+01	.00000	.00000	-.30086+04	-.96695-00
.7680	.67987-03	.44572+01	-.30578-02	-.15144+04	-.66260-02	-.39408+01	.00000	.00000	-.26443+04	-.11823+01
.7680	.67979-03	.44522+01	-.30578-02	-.15144+04	-.66255-02	-.39407+01	.00000	.00000	-.26444+04	-.11822+01
.8640	.14093-02	.64451+02	-.28746-02	-.15144+04	-.83043-02	-.10373+01	.00000	.00000	-.20730+04	-.31119-00
.8640	.14091-02	.64435+02	-.28746-02	-.15144+04	-.83039-02	-.10381+01	.00000	.00000	-.20731+04	-.31142-00
.9600	.21572-02	.17817+03	-.26895-02	-.15144+04	-.62226-02	.10188+02	.00000	.00000	-.14860+04	.30564+01

BRANCH SHELL PART NO 4

.0000	-.26895-02	.21808-03	-.21571-02	-.28061+03	-.62231-02	-.12697+01	.00000	.00000	-.13738+04	.13303+01
.0425	-.24199-02	.19813-03	-.20303-02	-.23539+03	-.64692-02	-.13772+01	.00000	.00000	-.14191+04	.14378+01
.0850	-.21393-02	.17548-03	-.19016-02	-.18433+03	-.67363-02	-.14986+01	.00000	.00000	-.14701+04	.15593+01
.0850	-.21393-02	.17548-03	-.19016-02	-.18433+03	-.67363-02	-.14986+01	.00000	.00000	-.14701+04	.15593+01
.1275	-.18469-02	.14960-03	-.17709-02	-.12637+03	-.70273-02	-.16365+01	.00000	.00000	-.15281+04	.16971+01
.1700	-.15416-02	.11988-03	-.16377-02	-.60189+02	-.73455-02	-.17939+01	.00000	.00000	-.15943+04	.18545+01

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BRANCH SHELL PART NO 5										
.0000	.16377-02	.60189+02	.15416-02	.23007-04	.73455-02	.17939+01	.00000	.00000	.94572+03	.53816-00
.0438	.19735-02	.22670+02	.14039-02	.23007-04	.78235-02	.35986-01	.00000	.00000	.63076+03	.10796-01
.0875	.23131-02	.30295-00	.12711-02	.23007-04	.76581-02	.41134-00	.00000	.00000	.31214+03	.12340+00
.0875	.23132-02	.29884-00	.12711-02	.15184-04	.76581-02	.41144-00	.00000	.00000	.31209+03	.12343+00
.1313	.26432-02	.71391+01	.11430-02	.15184-04	.74511-02	.20820-00	.00000	.00000	.24604+01	.62461-01
.1750	.29677-02	.19136-01	.10196-02	.15184-04	.74034-02	.11081-02	.00000	.00000	.30193+03	.33242-03

MAIN SHELL PART NO 6										
.0000	.21571-02	.10246+03	.26895-02	.15144+04	.62231-02	.11455+02	.00000	.00000	.14861+04	.34366+01
.0194	.22656-02	.74154+02	.26514-02	.15144+04	.50116-02	.97432+01	.00000	.00000	.14404+04	.29230+01
.0387	.23524-02	.45252+02	.26122-02	.15144+04	.39650-02	.85858+01	.00000	.00000	.14178+04	.25757+01
.0387	.23524-02	.45252+02	.26122-02	.15144+04	.39650-02	.85858+01	.00000	.00000	.14178+04	.25757+01
.0581	.24199-02	.16131+02	.25720-02	.15144+04	.30190-02	.79911+01	.00000	.00000	.14154+04	.23973+01
.0775	.24696-02	.12865+02	.25306-02	.15144+04	.21089-02	.79599+01	.00000	.00000	.14319+04	.23880+01
.0775	.24696-02	.12864+02	.25306-02	.15144+04	.21089-02	.79599+01	.00000	.00000	.14319+04	.23880+01
.0969	.25015-02	.41400+02	.24879-02	.15144+04	.11703-02	.84866+01	.00000	.00000	.14672+04	.25460+01
.1162	.25144-02	.69134+02	.24438-02	.15144+04	.13971-03	.95590+01	.00000	.00000	.15225+04	.28677+01
.1162	.25144-02	.69133+02	.24438-02	.15144+04	.13971-03	.95590+01	.00000	.00000	.15225+04	.28677+01
.1356	.25059-02	.95688+02	.23982-02	.15144+04	.10444-02	.11158+02	.00000	.00000	.16004+04	.33474+01
.1550	.24725-02	.12063+03	.23509-02	.15144+04	.24410-02	.13257+02	.00000	.00000	.17046+04	.39770+01

BRANCH SHELL PART NO 7										
.0000	.23509-02	.94859-04	.24725-02	.26596+03	.24410-02	.59422+01	.00000	.00000	.13301+04	.14390+01
.0292	.24378-02	.78630-04	.23706-02	.23624+03	.35057-02	.60680+01	.00000	.00000	.13598+04	.13132+01
.0585	.25563-02	.61035-04	.22677-02	.20396+03	.46029-02	.62046+01	.00000	.00000	.13921+04	.11766+01
.0585	.25563-02	.61035-04	.22677-02	.20396+03	.46029-02	.62046+01	.00000	.00000	.13921+04	.11766+01
.0877	.27075-02	.41915-04	.21637-02	.16881+03	.57353-02	.63533+01	.00000	.00000	.14272+04	.10279+01
.1170	.28922-02	.21085-04	.20584-02	.13045+03	.69063-02	.65157+01	.00000	.00000	.14656+04	.86558-00

BRANCH SHELL PART NO 8										
.0000	.20584-02	.13045+03	.28922-02	.17643-04	.69063-02	.65156+01	.00000	.00000	.16404+04	.19547+01
.0325	.22937-02	.80982+02	.30121-02	.17643-04	.74985-02	.31088+01	.00000	.00000	.13204+04	.93263-00
.0650	.25422-02	.42530+02	.31295-02	.17643-04	.77538-02	.11322+01	.00000	.00000	.98240+03	.33966-00
.0650	.25422-02	.42530+02	.31295-02	.59605-06	.77538-02	.11322+01	.00000	.00000	.98240+03	.33966-00
.0975	.27957-02	.15494+02	.32444-02	.59605-06	.78302-02	.22046-00	.00000	.00000	.63753+03	.66139-01
.1300	.30504-02	.43532-03	.33567-02	.59605-06	.78388-02	.37872-05	.00000	.00000	.29109+03	.11362-05

MAIN SHELL PART NO 9										
.0000	.24725-02	.14532+03	.23509-02	.15144+04	.24410-02	.73143+01	.00000	.00000	.17046+04	.21943+01
.0787	.22049-02	.63236+02	.21457-02	.15144+04	.37367-02	.68590-00	.00000	.00000	.21474+04	.20577-00
.1575	.19468-02	.13869+02	.19199-02	.15144+04	.25997-02	.35172+01	.00000	.00000	.25779+04	.10552+01
.1575	.19468-02	.13870+02	.19199-02	.15144+04	.25997-02	.35172+01	.00000	.00000	.25778+04	.10552+01
.2362	.18103-02	.88228+01	.16753-02	.15144+04	.86298-03	.35735+01	.00000	.00000	.28787+04	.10720+01
.3150	.18032-02	.14865+02	.14147-02	.15144+04	.60252-03	.25632+01	.00000	.00000	.30432+04	.76896-00
.3150	.18032-02	.14866+02	.14147-02	.15144+04	.60247-03	.25631+01	.00000	.00000	.30432+04	.76892-00



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.3937	.18911-02	.12895+02	.11405-02	.15144+04	.15430-02	.14396+01	.00000	.00000	.31082+04	.43187-00
.4725	.20337-02	.85146+01	.85432-03	.15144+04	.20116-02	.59257-00	.00000	.00000	.31165+04	.17777-00
.4725	.20337-02	.85152+01	.85432-03	.15144+04	.20115-02	.59286-00	.00000	.00000	.31165+04	.17766-00
.5512	.21996-02	.45491+01	.55690+03	.15144+04	.21607-02	.85708-01	.00000	.00000	.31011+04	.25712-01
.6300	.23695-02	.19153+01	.24850-03	.15144+04	.21347-02	.15980-00	.00000	.00000	.30819+04	.47941-01
.6300	.23695-02	.19165+01	.24850-03	.15144+04	.21347-02	.15963-00	.00000	.00000	.30820+04	.47889-01
.7087	.25338-02	.47672-00	.70957-04	.15144+04	.20326-02	.24774-00	.00000	.00000	.30690+04	.74322-01
.7875	.26891-02	.36991-00	.40166-03	.15144+04	.19102-02	.25044-00	.00000	.00000	.30658+04	.75131-01
.7875	.26891-02	.36945-00	.40166-03	.15144+04	.19102-02	.25044-00	.00000	.00000	.30658+04	.75132-01
.8662	.28351-02	.13475+01	.74386-03	.15144+04	.18019-02	.18599-00	.00000	.00000	.30724+04	.55798-01
.9450	.29743-02	.30902+01	.10978-02	.15144+04	.17470-02	.17829-01	.00000	.00000	.30862+04	.53487-02
.9450	.29743-02	.30894+01	.10978-02	.15144+04	.17471-02	.17897-01	.00000	.00000	.30862+04	.53690-02
1.0237	.31134-02	.59008+01	.14635-02	.15144+04	.18137-02	.32933-00	.00000	.00000	.31004+04	.98800-01
1.1025	.32659-02	.93647+01	.18410-02	.15144+04	.21092-02	.92995-00	.00000	.00000	.31013+04	.27899-00
1.1025	.32659-02	.93628+01	.18410-02	.15144+04	.21092-02	.92964-00	.00000	.00000	.31013+04	.27889-00
1.1812	.34550-02	.11743-02	.22297-02	.15144+04	.27631-02	.17775-01	.00000	.00000	.30657+04	.53325-00
1.2600	.37129-02	.92933+01	.26285-02	.15144+04	.38577-02	.26550+01	.00000	.00000	.29617+04	.79651-00
1.2600	.37128-02	.92941+01	.26285-02	.15144+04	.38571-02	.26545+01	.00000	.00000	.29618+04	.79646-00
1.3387	.40716-02	.41087+01	.30357-02	.15144+04	.52802-02	.29554+01	.00000	.00000	.27580+04	.88662-00
1.4175	.45395-02	.36198+02	.34489-02	.15144+04	.64874-02	.15160+01	.00000	.00000	.24470+04	.45480-00
1.4175	.45394-02	.36182+02	.34489-02	.15144+04	.64867-02	.15166+01	.00000	.00000	.24471+04	.45499-00
1.4962	.50551-02	.93034+02	.38663-02	.15144+04	.62043-02	.34019+01	.00000	.00000	.20912+04	.10206+01
1.5750	.54199-02	.17184+03	.42887-02	.15144+04	.22040-02	.13733+02	.00000	.00000	.18872+04	.41200+01

BRANCH SHELL PART NO 10

.0000	.42887-02	.14215-03	.54198-02	.34132+03	.22058-02	.27736-00	.00000	.00000	.29684+04	.24124+01
.0297	.43545-02	.10328-03	.52243-02	.26664+03	.22184-02	.21667-00	.00000	.00000	.30431+04	.24731+01
.0595	.44207-02	.61035-04	.50274-02	.18541+03	.22330-02	.15066-00	.00000	.00000	.31243+04	.25391+01
.0595	.44207-02	.61035-04	.50274-02	.18541+03	.22330-02	.15067-00	.00000	.00000	.31243+04	.25391+01
.0692	.44874-02	.14995-04	.48290-02	.96833+02	.22500-02	.78686-01	.00000	.00000	.32129+04	.26111+01
.1190	.45546-02	.35304-04	.46290-02	.30279-04	.22695-02	.91710-05	.00000	.00000	.33097+04	.26898+01

MAIN SHELL PART NO 11

.0000	.54198-02	.16952+03	.42887-02	.15144+04	.22058-02	.13451+02	.00000	.00000	.18873+04	.40353+01
.0483	.54457-02	.11944+03	.45538-02	.15144+04	.78132-03	.64854+01	.00000	.00000	.19849+04	.19456+01
.0967	.53728-02	.76138+02	.48266-02	.15144+04	.19979-02	.17938+01	.00000	.00000	.21795+04	.53813-00
.1450	.52709-02	.42274+02	.51079-02	.15144+04	.20735-02	.10281+01	.00000	.00000	.24017+04	.30844-00
.1450	.52709-02	.42271+02	.51079-02	.15144+04	.20737-02	.10279+01	.00000	.00000	.24018+04	.30836-00
.1933	.51826-02	.18051+02	.53978-02	.15144+04	.15065-02	.24485+01	.00000	.00000	.26098+04	.73455-00
.2417	.51297-02	.23137+01	.56960-02	.15144+04	.65651-03	.29098+01	.00000	.00000	.27825+04	.81294-00
.2900	.51198-02	.67025+01	.60021-02	.15144+04	.23939-03	.27805+01	.00000	.00000	.29129+04	.83414-00
.2900	.51198-02	.67049+01	.60021-02	.15144+04	.23937-03	.27803+01	.00000	.00000	.29130+04	.83409-00
.3383	.51513-02	.10857+02	.63154-02	.15144+04	.10431-02	.23398+01	.00000	.00000	.30029+04	.70195-00
.3867	.52181-02	.11807+02	.66355-02	.15144+04	.16893-02	.17822+01	.00000	.00000	.30588+04	.53465-00
.4350	.53118-02	.10883+02	.69621-02	.15144+04	.21608-02	.12285+01	.00000	.00000	.30889+04	.36854-00
.4350	.53118-02	.10883+02	.69621-02	.15144+04	.21608-02	.12285+01	.00000	.00000	.30889+04	.36855-00
.4833	.54243-02	.90472+01	.72948-02	.15144+04	.24692-02	.74465-00	.00000	.00000	.31013+04	.22339-00

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.5317	.55483+02	.69205+01	.76334+02	.15144+04	.26408+02	.35844+00	.00000	.00000	.31031+04	.10753+00
.5800	.56779+02	.48386+01	.79780+02	.15144+04	.27068+02	.74813+01	.00000	.00000	.31001+04	.22444+01
.5800	.56779+02	.48410+01	.79780+02	.15144+04	.27067+02	.74543+01	.00000	.00000	.31001+04	.22363+01
.6283	.58087+02	.29219+01	.83284+02	.15144+04	.26982+02	.11239+00	.00000	.00000	.30963+04	.33717+01
.6767	.59380+02	.11307+01	.86847+02	.15144+04	.26445+02	.21002+00	.00000	.00000	.30946+04	.63007+01
.7250	.60641+02	.65867+00	.90470+02	.15144+04	.25730+02	.22174+00	.00000	.00000	.30964+04	.66523+01
.7250	.60641+02	.65936+00	.90470+02	.15144+04	.25730+02	.22166+00	.00000	.00000	.30964+04	.66499+01
.7733	.61869+02	.26074+01	.94154+02	.15144+04	.25118+02	.14367+00	.00000	.00000	.31017+04	.43101+01
.8217	.63075+02	.48518+01	.97899+02	.15144+04	.24914+02	.35206+01	.00000	.00000	.31094+04	.10562+01
.8700	.64289+02	.74467+01	.10171+01	.15144+04	.25473+02	.33107+00	.00000	.00000	.31169+04	.99322+01
.8700	.64289+02	.74460+01	.10171+01	.15144+04	.25473+02	.33100+00	.00000	.00000	.31170+04	.99300+01
.9183	.65557+02	.10291+02	.10557+01	.15144+04	.27206+02	.75912+00	.00000	.00000	.31199+04	.22774+00
.9667	.66945+02	.13055+02	.10950+01	.15144+04	.30565+02	.13247+01	.00000	.00000	.31120+04	.39741+00
1.0150	.68545+02	.15085+02	.11349+01	.15144+04	.35990+02	.20096+01	.00000	.00000	.30853+04	.60287+00
1.0150	.68545+02	.15085+02	.11349+01	.15144+04	.35990+02	.20096+01	.00000	.00000	.30853+04	.60287+00
1.0633	.70463+02	.15332+02	.11754+01	.15144+04	.43802+02	.27545+01	.00000	.00000	.30298+04	.82636+00
1.1117	.72818+02	.12291+02	.12163+01	.15144+04	.54038+02	.34389+01	.00000	.00000	.29351+04	.10317+01
1.1600	.75718+02	.40069+01	.12577+01	.15144+04	.66202+02	.38584+01	.00000	.00000	.27918+04	.11575+01
1.1600	.75718+02	.40066+01	.12577+01	.15144+04	.66201+02	.38583+01	.00000	.00000	.27918+04	.11575+01
1.2083	.79228+02	.11817+02	.12995+01	.15144+04	.78949+02	.37048+01	.00000	.00000	.25944+04	.11114+01
1.2567	.83319+02	.37547+02	.13415+01	.15144+04	.89706+02	.25562+01	.00000	.00000	.23461+04	.76686+00
1.3050	.87801+02	.75113+02	.13838+01	.15144+04	.94282+02	.11613+00	.00000	.00000	.20646+04	.34831+01
1.3050	.87801+02	.75113+02	.13838+01	.15144+04	.94282+02	.11610+00	.00000	.00000	.20646+04	.34831+01
1.3533	.92235+02	.12520+03	.14263+01	.15144+04	.86538+02	.49078+01	.00000	.00000	.17899+04	.14723+01
1.4017	.95037+02	.18607+03	.14691+01	.15144+04	.58271+02	.12395+02	.00000	.00000	.15924+04	.37184+01
1.4500	.97377+02	.25205+03	.15123+01	.15144+04	.51604+04	.22980+02	.00000	.00000	.15811+04	.68940+01

MAIN SHELL PART NO 12

.0000	.15473+01	.45185+03	.91720+02	.14673+04	.51621+04	.22980+02	.00000	.00000	.15670+04	.68913+01
.0291	.15430+01	.42122+03	.94393+02	.14621+04	.23109+02	.10521+02	.00000	.00000	.22510+04	.63703+01
.0291	.15430+01	.42122+03	.94393+02	.14621+04	.23109+02	.10521+02	.00000	.00000	.22510+04	.63703+01
.0581	.15353+01	.40899+03	.97173+02	.14477+04	.28762+02	.12417+01	.00000	.00000	.30542+04	.28027+02
.0581	.15354+01	.40899+03	.97173+02	.14477+04	.28760+02	.12417+01	.00000	.00000	.30542+04	.28027+02
.0872	.15267+01	.41877+03	.10003+01	.14222+04	.30617+02	.12770+02	.00000	.00000	.39754+04	.60214+02
.0872	.15267+01	.41877+03	.10003+01	.14222+04	.30617+02	.12770+02	.00000	.00000	.39754+04	.60214+02
.1163	.15177+01	.45435+03	.10294+01	.13839+04	.31244+02	.24611+02	.00000	.00000	.50162+04	.10514+03
.1163	.15177+01	.45435+03	.10294+01	.13839+04	.31244+02	.24611+02	.00000	.00000	.50162+04	.10514+03
.1453	.15086+01	.51979+03	.10590+01	.13307+04	.31359+02	.37396+02	.00000	.00000	.61792+04	.16510+03

MAIN SHELL PART NO 13

.0000	.87569+02	.13018+03	.16218+01	.14226+04	.31359+02	.37396+02	.00000	.00000	.26886+04	.11219+02
.0168	.87150+02	.13266+03	.16381+01	.14226+04	.18742+02	.35189+02	.00000	.00000	.27485+04	.10557+02
.0336	.86936+02	.13440+03	.16543+01	.14226+04	.68974+03	.32948+02	.00000	.00000	.27790+04	.98845+01
.0503	.86914+02	.13588+03	.16705+01	.14226+04	.41630+03	.30681+02	.00000	.00000	.27821+04	.92043+01
.0503	.86914+02	.13588+03	.16705+01	.14226+04	.41631+03	.30681+02	.00000	.00000	.27821+04	.92043+01
.0671	.87071+02	.13751+03	.16868+01	.14226+04	.14431+02	.28388+02	.00000	.00000	.27597+04	.85164+01
.0839	.87394+02	.13970+03	.17030+01	.14226+04	.23896+02	.26064+02	.00000	.00000	.27136+04	.78191+01

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.1007	.87869-02	.14283+03	.17192+01	.14226+04	.32547-02	.23695+02	.00000	.00000	.26459+04	.71085+01
.1007	.87869-02	.14280+03	.17192+01	.14226+04	.32547-02	.23695+02	.00000	.00000	.26459+04	.71086+01
.1174	.88482-02	.14720+03	.17354+01	.14226+04	.40364-02	.21265+02	.00000	.00000	.25585+04	.63794+01
.1342	.89218-02	.15318+03	.17515+01	.14226+04	.47321-02	.18747+02	.00000	.00000	.24533+04	.56241+01
.1510	.90064-02	.16101+03	.17676+01	.14226+04	.53384-02	.16114+02	.00000	.00000	.23326+04	.48342+01
.1510	.90064-02	.16098+03	.17676+01	.14226+04	.53384-02	.16115+02	.00000	.00000	.23326+04	.48344+01
.1678	.91004-02	.17089+03	.17837+01	.14226+04	.58508-02	.13334+02	.00000	.00000	.21985+04	.40001+01
.1846	.92022-02	.18309+03	.17997+01	.14226+04	.62633-02	.10367+02	.00000	.00000	.20533+04	.31102+01
.2013	.93100-02	.19774+03	.18157+01	.14226+04	.65690-02	.71761+01	.00000	.00000	.18994+04	.21528+01
.2013	.93100-02	.19771+03	.18157+01	.14226+04	.65690-02	.71766+01	.00000	.00000	.18994+04	.21530+01
.2181	.94220-02	.21493+03	.18316+01	.14226+04	.67592-02	.37186+01	.00000	.00000	.17397+04	.11156+01
.2349	.95361-02	.23479+03	.18474+01	.14226+04	.68239-02	.50332+01	.00000	.00000	.15768+04	.15100+01
.2517	.96502-02	.25732+03	.18632+01	.14226+04	.67516-02	.41748+01	.00000	.00000	.14140+04	.12525+01
.2517	.96502-02	.25729+03	.18632+01	.14226+04	.67516-02	.41744+01	.00000	.00000	.14140+04	.12523+01
.2684	.97618-02	.28245+03	.18789+01	.14226+04	.65290-02	.86986+01	.00000	.00000	.12547+04	.26096+01
.2852	.98684-02	.31017+03	.18946+01	.14226+04	.61417-02	.13667+02	.00000	.00000	.11027+04	.41000+01
.3020	.99669-02	.34028+03	.19103+01	.14226+04	.55732-02	.19120+02	.00000	.00000	.96212+03	.57360+01
MAIN SHELL PART NO. 14										
1.5708	.99670-02	.34025+03	.19103+01	.14226+04	.55733-02	.19119+02	.00000	.00000	.14546+04	.23455+02
1.6140	.10846+01	.29494+03	.18755+01	.14364+04	.53705-02	.22649+02	.00000	.00000	.12623+04	.15788+02
1.6572	.11706-01	.25130+03	.18370-01	.14484+04	.51481-02	.25714+02	.00000	.00000	.10816+04	.88741+01
1.7004	.12547+01	.20936+03	.17947+01	.14589+04	.49050-02	.28337+02	.00000	.00000	.91226+03	.26793+01
1.7004	.12547+01	.20936+03	.17947+01	.14589+04	.49050-02	.28337+02	.00000	.00000	.91225+03	.26791+01
1.7436	.13367+01	.16915+03	.17490+01	.14681+04	.46401-02	.30536+02	.00000	.00000	.75411+03	.28245+01
1.7868	.14164+01	.13071+03	.16998+01	.14763+04	.43521-02	.32324+02	.00000	.00000	.60715+03	.76620+01
1.8300	.14937+01	.94079+02	.16475+01	.14837+04	.40392-02	.33713+02	.00000	.00000	.47141+03	.11855+02
1.8300	.14937+01	.94077+02	.16475+01	.14837+04	.40393-02	.33713+02	.00000	.00000	.47141+03	.11855+02
1.8732	.15684+01	.59325+02	.15920+01	.14906+04	.36996-02	.34707+02	.00000	.00000	.34706+03	.15421+02
1.9164	.16403+01	.26510+02	.15336+01	.14972+04	.33311-02	.35310+02	.00000	.00000	.23435+03	.18374+02
1.9596	.17093+01	.43011+01	.14726+01	.15037+04	.29312-02	.35523+02	.00000	.00000	.13370+03	.20725+02
1.9596	.17093+01	.43048+01	.14726+01	.15037+04	.29312-02	.35523+02	.00000	.00000	.13370+03	.20725+02
2.0028	.17751+01	.33043+02	.14089+01	.15105+04	.24974-02	.35343+02	.00000	.00000	.45646+02	.22480+02
2.0460	.18378+01	.59640+02	.13430+01	.15178+04	.20266-02	.34764+02	.00000	.00000	.29083+02	.23643+02
2.0892	.18969+01	.84028+02	.12749+01	.15258+04	.15159-02	.33779+02	.00000	.00000	.89570+02	.24213+02
2.0892	.18969+01	.84035+02	.12749+01	.15258+04	.15160-02	.33780+02	.00000	.00000	.89571+02	.24213+02
2.1324	.19524+01	.10615+03	.12050+01	.15350+04	.96224-03	.32378+02	.00000	.00000	.13468+03	.24183+02
2.1756	.20040+01	.12595+03	.11335+01	.15456+04	.36233-03	.30549+02	.00000	.00000	.16301+03	.23543+02
2.2188	.20515+01	.14340+03	.10607+01	.15579+04	.28658-03	.28278+02	.00000	.00000	.17288+03	.22280+02
2.2188	.20515+01	.14342+03	.10607+01	.15579+04	.28638-03	.28279+02	.00000	.00000	.17286+03	.22280+02
2.2620	.20945+01	.15851+03	.98684-02	.15722+04	.98661-03	.25550+02	.00000	.00000	.16225+03	.20375+02
2.3052	.21329+01	.17126+03	.91237+02	.15889+04	.17395-02	.22346+02	.00000	.00000	.12878+03	.17803+02
2.3484	.21661+01	.18176+03	.83764-02	.16080+04	.25446-02	.18649+02	.00000	.00000	.69678+02	.14539+02
2.3484	.21661+01	.18180+03	.83764-02	.16079+04	.25442-02	.18651+02	.00000	.00000	.69629+02	.14538+02
2.3916	.21938+01	.19019+03	.76308+02	.16297+04	.33985-02	.14439+02	.00000	.00000	.18247+02	.10551+02
2.4348	.22156+01	.19670+03	.68917+02	.16539+04	.42949-02	.96893+01	.00000	.00000	.13844+03	.58092+01
2.4780	.22309+01	.20167+03	.61647+02	.16802+04	.52196-02	.43724+01	.00000	.00000	.29477+03	.28303+00
2.4780	.22309+01	.20177+03	.61649+02	.16800+04	.52186-02	.43762+01	.00000	.00000	.29497+03	.28049+00

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2.5212	.22391-01	-.20571+03	.54562-02	-.17075+04	.61483-02	-.15494+01	.00000	.00000	-.49129+03	-.60535+01
2.5644	.22397-01	-.20929+03	.47731-02	-.17346+04	.70448-02	-.81372+01	.00000	.00000	-.75121+03	-.13204+02
2.6076	.22322-01	-.21339+03	.41235-02	-.17584+04	.78471-02	-.15474+02	.00000	.00000	-.10173+04	-.21152+02
2.6076	.22322-01	-.21371+03	.41240-02	-.17581+04	.78441-02	-.15467+02	.00000	.00000	-.10181+04	-.21166+02
2.6508	.22166-01	-.21943+03	.35174-02	-.17748+04	.84554-02	-.23702+02	.00000	.00000	-.13506+04	-.29843+02
2.6940	.21932-01	-.22806+03	.29642-02	-.17776+04	.87298-02	-.33045+02	.00000	.00000	-.17265+04	-.39238+02
2.7372	.21638-01	-.24091+03	.24762-02	-.17572+04	.84316-02	-.43847+02	.00000	.00000	-.21320+04	-.48971+02
2.7372	.21636-01	-.24205+03	.24779-02	-.17546+04	.84183-02	-.43852+02	.00000	.00000	-.21362+04	-.49044+02
2.7804	.21321-01	-.26021+03	.20690-02	-.16968+04	.71513-02	-.56737+02	.00000	.00000	-.25438+04	-.58475+02
2.8236	.21065-01	-.28352+03	.17540-02	-.15848+04	.42765-02	-.72563+02	.00000	.00000	-.28995+04	-.66309+02
2.8668	.21026-01	-.30931+03	.15486-02	-.13996+04	.12630-02	-.92812+02	.00000	.00000	-.30995+04	-.70008+02
MAIN SHELL PART NO 15										
.0000	.42059-02	-.12488+04	.20648-01	-.67782+03	-.13049-02	-.92791+02	.00000	.00000	-.54100+04	-.27837+02
.1300	.44754-02	-.40848+03	.21990-01	-.67782+03	-.23083-02	.10344+02	.00000	.00000	-.38052+04	.31031+01
.1300	.44754-02	-.40848+03	.21990-01	-.67782+03	-.23083-02	.10344+02	.00000	.00000	-.38052+04	.31031+01
.2600	.47302-02	-.52486+00	.23310-01	-.67782+03	-.14987-02	.32667+02	.00000	.00000	-.22884+04	.98001+01
.2600	.47302-02	-.10786+01	.23310-01	-.67782+03	-.14981-02	.32719+02	.00000	.00000	-.22883+04	.98156+01
.3900	.48622-02	-.10845+03	.24615-01	-.67782+03	-.58236-03	.23554+02	.00000	.00000	-.15024+04	.70662+01
.3900	.48622-02	-.10787+03	.24615-01	-.67782+03	-.58174-03	.23605+02	.00000	.00000	-.15025+04	.70815+01
.5200	.48924-02	-.94192+02	.25913-01	-.67782+03	-.63695-04	.28667+01	.00000	.00000	-.12806+04	.29600+01
.5200	.48994-02	-.93601+02	.25913-01	-.67782+03	-.63117-04	.29917+01	.00000	.00000	-.12807+04	.29752+01
.6500	.48949-02	-.61019+02	.27211-01	-.67782+03	-.79982-04	.47474-01	.00000	.00000	-.13073+04	.14242-01
.6500	.48949-02	-.60424+02	.27211-01	-.67782+03	-.80539-04	.37608-02	.00000	.00000	-.13074+04	.11282-02
.7800	.48892-02	-.39805+02	.28509-01	-.67782+03	-.26463-04	-.64096+01	.00000	.00000	-.13412+04	-.19229+01
.7800	.48892-02	-.39213+02	.28509-01	-.67782+03	-.25923-04	-.63580+01	.00000	.00000	-.13413+04	-.19074+01
.9100	.49085-02	-.10783+02	.29807-01	-.67782+03	-.28981-03	-.99248+01	.00000	.00000	-.12264+04	-.29775+01
.9100	.49085-02	-.10189+02	.29807-01	-.67782+03	-.28927-03	-.98730+01	.00000	.00000	-.12265+04	-.29619+01
1.0400	.49657-02	-.76554+02	.31102-01	-.67782+03	-.57450-03	-.65148+01	.00000	.00000	-.88577+03	-.19544+01
1.0400	.49657-02	-.77154+02	.31102-01	-.67782+03	-.57398-03	-.64625+01	.00000	.00000	-.88583+03	-.19388+01
1.1700	.50432-02	-.27307+03	.32392-01	-.67782+03	-.50709-03	.14991+02	.00000	.00000	-.42459+03	.44973+01
1.1700	.50431-02	-.27364+03	.32392-01	-.67782+03	-.50655-03	.15041+02	.00000	.00000	-.42471+03	.45124+01
1.3000	.50484-02	-.55195+03	.33677-01	-.67782+03	-.70474-03	.68558+02	.00000	.00000	-.39355+03	.20568+02
MAIN SHELL PART NO 16										
.0000	.33677-01	-.67782+03	-.50483-02	-.55257+03	.70541-03	.68615+02	.00000	.00000	-.47522+03	-.21826+01
.0673	.33620-01	-.57927+03	-.43763-02	-.56289+03	.96254-03	.35338+02	.00000	.00000	-.49919+03	-.20753+02
.1347	.33549-01	-.47916+03	-.37058-02	-.57084+03	.11529-02	.79728+01	.00000	.00000	-.54284+03	-.35616+02
.1347	.33549-01	-.47916+03	-.37058-02	-.57083+03	.11528-02	.79711+01	.00000	.00000	-.54284+03	-.35615+02
.2020	.33467-01	-.37644+03	-.30355-02	-.57010+03	.12660-02	-.13096+02	.00000	.00000	-.60982+03	-.47617+02
.2693	.33380-01	-.26887+03	-.23641-02	-.54512+03	.12983-02	-.26729+02	.00000	.00000	-.71241+03	-.58146+02
.2693	.33380-01	-.26887+03	-.23641-02	-.54513+03	.12982-02	-.26730+02	.00000	.00000	-.71236+03	-.58144+02
.3367	.33294-01	-.15060+03	-.16898-02	-.44502+03	.12731-02	-.29067+02	.00000	.00000	-.89788+03	-.70868+02
.4040	.33207-01	-.22211-02	-.10124-02	.43006-00	.13373-02	.14188-02	.00000	.00000	-.14356+04	-.10442+03

MAIN SHELL STRESS ANALYSIS..... HOT END DISPLACER MORIMOTO MAR 73

DEFLECTIONS AND STRESSES FOR WAVE NUMBER NX= 0

2800.PSI BURST PRESSURE PLUS TEMPERATURE LOADING



GARRETT AIRSEARCH MANUFACTURING COMPANY OF CALIFORNIA

X	W	UPHI	UTHETA	BPFI	SPHI IN	SPHI OUT	STHTA IN	STHTA OUT	SFITH IN	SFITH OUT
MAIN SHELL PART NO 1										
.9000	.00000	.00000	.00000	.00000	.52687+05	-.57475+05	-.15901+05	-.48950+05	.00000	.00000
.0798	.38902-04	.10372-03	.00000	-.85769-03	.21189+05	-.25976+05	-.22438+05	-.36587+05	.00000	.00000
.0798	.38902-04	.10372-03	.00000	-.85769-03	.21189+05	-.25976+05	-.22438+05	-.36587+05	.00000	.00000
.1596	.12148-03	.20355-03	.00000	-.11341-02	.31517+03	-.51025+04	-.22517+05	-.24142+05	.00000	.00000
.1596	.12147-03	.20355-03	.00000	-.11340-02	.31866+03	-.51060+04	-.22517+05	-.24144+05	.00000	.00000
.2394	.21008-03	.29809-03	.00000	-.10387-02	.12545+05	.77579+04	-.19741+05	-.13650+05	.00000	.00000
.2394	.21006-03	.29809-03	.00000	-.10387-02	.12543+05	.77554+04	-.19742+05	-.13652+05	.00000	.00000
.3192	.28133-03	.38773-03	.00000	-.71841-03	.20254+05	.15467+05	-.16719+05	-.60031+04	.00000	.00000
.3192	.28131-03	.38773-03	.00000	-.71846-03	.20252+05	.15465+05	-.16720+05	-.60045+04	.00000	.00000
.3990	.32113-03	.47398-03	.00000	-.26103-03	.25122+05	.20335+05	-.15200+05	-.15626+04	.00000	.00000
.3990	.32112-03	.47398-03	.00000	-.26109-03	.25121+05	.20334+05	-.15200+05	-.15635+04	.00000	.00000
.4788	.32060-03	.55900-03	.00000	-.28660-03	.28439+05	.23651+05	-.16234+05	-.60711+03	.00000	.00000
.4788	.32060-03	.55901-03	.00000	.28652-03	.28438+05	.23650+05	-.16234+05	-.60749+03	.00000	.00000
.5586	.27383-03	.64543-03	.00000	.89207-03	.30169+05	.25382+05	-.20255+05	-.35896+04	.00000	.00000
.5586	.27384-03	.64543-03	.00000	.89198-03	.30169+05	.25381+05	-.20254+05	-.35894+04	.00000	.00000
.6384	.17796-03	.73615-03	.00000	.15056-02	.28764+05	.23977+05	-.27012+05	-.11189+05	.00000	.00000
.6384	.17798-03	.73615-03	.00000	.15055-02	.28764+05	.23977+05	-.27010+05	-.11188+05	.00000	.00000
.7182	.35974-04	.83405-03	.00000	.20247-02	.21070+05	.16282+05	-.35335+05	-.24129+05	.00000	.00000
.7182	.35995-04	.83405-03	.00000	.20246-02	.21070+05	.16283+05	-.35333+05	-.24127+05	.00000	.00000
.7980	.13772-03	.94157-03	.00000	.22594-02	.24421+04	-.23453+04	-.42751+05	-.42722+05	.00000	.00000
MAIN SHELL PART NO 2										
.1935	-.95047-03	.45937-04	.00000	.22593-02	.19516+05	-.12885+06	-.51554+05	-.78480+05	.00000	.00000
.2624	-.63481-03	.18617-04	.00000	.65608-02	.35523+05	-.10288+06	-.44341+05	-.78083+05	.00000	.00000
.3312	.30072-03	-.92512-04	.00000	-.10561-01	.45700+05	.82952+05	-.33060+05	-.62823+05	.00000	.00000
.3312	.30098-03	.92513-04	.00000	.10562-01	.45694+05	.82958+05	-.33053+05	-.62822+05	.00000	.00000
.4001	.13447-02	.21268-03	.00000	.11974-01	.51747+05	.66499+05	-.21302+05	-.44490+05	.00000	.00000
.4690	.22800-02	.38372-03	.00000	.11924-01	.56837+05	.51476+05	-.11341+05	-.26763+05	.00000	.00000
.4690	.22801-02	.38372-03	.00000	.11926-01	.56834+05	.51479+05	-.11338+05	-.26764+05	.00000	.00000
.5378	.30284-02	.59864-03	.00000	.10931-01	.62346+05	.37184+05	-.41038+04	-.10960+05	.00000	.00000
.6067	.35744-02	.84674-03	.00000	.93663-02	.67452+05	.24278+05	.71862+03	.21743+04	.00000	.00000
.6067	.35744-02	.84674-03	.00000	.93666-02	.67451+05	.24279+05	.71941+03	.21743+04	.00000	.00000
.6756	.39341-02	.11172-02	.00000	.75115-02	.71844+05	.13153+05	.34956+04	.12476+05	.00000	.00000
.7444	.41351-02	.14004-02	.00000	.55643-02	.75175+05	.40974+04	.47111+04	.20052+05	.00000	.00000
.7444	.41351-02	.14004-02	.00000	.55644-02	.75175+05	.40976+04	.47116+04	.20052+05	.00000	.00000
.8133	.42068-02	.16883-02	.00000	.36582-02	.77212+05	.27741+04	.48319+04	.25154+05	.00000	.00000
.8821	.41753-02	.19744-02	.00000	.18751-02	.77856+05	.75037+04	.42442+04	.28103+05	.00000	.00000
.8821	.41753-02	.19744-02	.00000	.18753-02	.77856+05	.75031+04	.42448+04	.28103+05	.00000	.00000



GARRETT AIRRESEARCH MANUFACTURING COMPANY
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.9510	.40624-02	-.22534-02	.00000	-.26064-03	-.77113405	.10235+05	.32468+04	.29227+05	.00000	.00000
1.0199	.38852-02	-.25211-02	.00000	.11654-02	-.75062+05	.11169+05	.20543+04	.78836+05	.00000	.00000
1.0199	.38852-02	-.25211-02	.00000	.11653-02	-.75062+05	.11169+05	.20544+04	.28836+05	.00000	.00000
1.0887	.36573-02	-.27741-02	.00000	.23981-02	-.71810+05	.10519+05	.81855+03	.27203+05	.00000	.00000
1.1576	.33889-02	-.30096-02	.00000	.34420-02	-.67476+05	.84931+04	-.35827+03	.24559+05	.00000	.00000
1.1576	.33889-02	-.30096-02	.00000	.34418-02	-.67476+05	.84931+04	-.35798+03	.24559+05	.00000	.00000
1.2265	.30882-02	-.32254-02	.00000	.43051-02	-.62170+05	.52730+04	-.14077+04	.21098+05	.00000	.00000
1.2953	.27616-02	-.34198-02	.00000	.49974-02	-.55988+05	.10136+04	-.22859+04	.16977+05	.00000	.00000
1.2953	.27616-02	-.34198-02	.00000	.49973-02	-.55988+05	.10136+04	-.22859+04	.16977+05	.00000	.00000
1.3642	.24143-02	-.35911-02	.00000	.55272-02	-.49002+05	.41648+04	-.29627+04	.12326+05	.00000	.00000
1.4331	.20505-02	-.37383-02	.00000	.59012-02	-.41259+05	.10175+05	-.34163+04	.72476+04	.00000	.00000
1.4331	.20505-02	-.37383-02	.00000	.59012-02	-.41259+05	.10175+05	-.34163+04	.72476+04	.00000	.00000
1.5019	.16741-02	-.38604-02	.00000	.61229-02	-.32784+05	.16963+05	-.36277+04	.18287+04	.00000	.00000
1.5708	.12887-02	-.39567-02	.00000	.61919-02	-.23571+05	.24507+05	-.35771+04	.38578+04	.00000	.00000

MAIN SHELL PART NO 3

.0000	.12888-02	-.39567-02	.00000	.61918-02	-.96332+05	.20610+05	-.25405+05	.96772+04	.00000	.00000
.0960	.48746-03	-.39477-02	.00000	.88185-02	-.26932+05	.48790+05	-.31783+05	.38340+05	.00000	.00000
.0960	.48746-03	-.39477-02	.00000	.88185-02	-.26932+05	.48790+05	-.31783+05	.38340+05	.00000	.00000
.1920	.22098-03	-.38955-02	.00000	.55426-02	-.10274+05	.65448+05	-.51280+05	.67832+05	.00000	.00000
.1920	.22098-03	-.38955-02	.00000	.55426-02	-.10274+05	.65448+05	-.51280+05	.67832+05	.00000	.00000
.2880	.56425-03	-.38070-02	.00000	.17560-02	-.16026+05	.59697+05	-.67461+05	.80562+05	.00000	.00000
.2880	.56425-03	-.38070-02	.00000	.17560-02	-.16026+05	.59697+05	-.67461+05	.80562+05	.00000	.00000
.3840	.60118-03	-.36916-02	.00000	.74706-03	-.25655+05	.50067+05	-.76450+05	.83774+05	.00000	.00000
.3840	.60118-03	-.36916-02	.00000	.74706-03	-.25655+05	.50067+05	-.76450+05	.83774+05	.00000	.00000
.4800	.45868-03	-.35557-02	.00000	.20886-02	-.31049+05	.44674+05	-.79307+05	.83395+05	.00000	.00000
.4800	.45868-03	-.35557-02	.00000	.20886-02	-.31049+05	.44674+05	-.79307+05	.83395+05	.00000	.00000
.5760	.21125-03	-.34027-02	.00000	.30834-02	-.30413+05	.45310+05	-.77537+05	.82006+05	.00000	.00000
.5760	.21125-03	-.34027-02	.00000	.30834-02	-.30413+05	.45310+05	-.77537+05	.82006+05	.00000	.00000
.6720	.14819-03	-.32356-02	.00000	.45238-02	-.25773+05	.49949+05	-.71587+05	.78840+05	.00000	.00000
.6720	.14819-03	-.32356-02	.00000	.45238-02	-.25773+05	.49949+05	-.71587+05	.78840+05	.00000	.00000
.7680	.67987-03	-.30578-02	.00000	.66260-02	-.23083+05	.52639+05	-.61673+05	.70540+05	.00000	.00000
.7680	.67987-03	-.30578-02	.00000	.66260-02	-.23083+05	.52639+05	-.61673+05	.70540+05	.00000	.00000
.8640	.67979-03	-.30578-02	.00000	.66255-02	-.23084+05	.52639+05	-.61676+05	.70542+05	.00000	.00000
.8640	.67979-03	-.30578-02	.00000	.66255-02	-.23084+05	.52639+05	-.61676+05	.70542+05	.00000	.00000
.9600	.14093-02	-.28746-02	.00000	.83043-02	-.33971+05	.41751+05	-.50657+05	.52991+05	.00000	.00000
.9600	.14093-02	-.28746-02	.00000	.83043-02	-.33971+05	.41751+05	-.50657+05	.52991+05	.00000	.00000
.9600	.14091-02	-.28746-02	.00000	.83039-02	-.33968+05	.41754+05	-.50660+05	.52996+05	.00000	.00000
.9600	.21572-02	-.26895-02	.00000	.62226-02	-.76066+05	.34401+03	-.48610+05	.25687+05	.00000	.00000

BRANCH SHELL PART NO 4

.0000	.26895-02	-.21571-02	.00000	.62231-02	-.25648+04	.86594+04	-.30670+05	.24284+05	.00000	.00000
.0425	.24199-02	-.20303-02	.00000	.64692-02	-.14026+04	.80132+04	-.31832+05	.24930+05	.00000	.00000
.0850	.21393-02	-.19016-02	.00000	.67363-02	-.89899+02	.72834+04	-.33145+05	.25660+05	.00000	.00000
.0850	.21393-02	-.19016-02	.00000	.67363-02	-.89893+02	.72834+04	-.33145+05	.25660+05	.00000	.00000
.1275	.18469-02	-.17709-02	.00000	.70273-02	-.14003+04	.64549+04	-.34635+05	.26489+05	.00000	.00000
.1700	.15416-02	-.16377-02	.00000	.73455-02	-.31015+04	.55091+04	-.36336+05	.27434+05	.00000	.00000

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AIRESEARCH MANUFACTURING COMPANY
OF CALIFORNIA

BRANCH SHELL PART NO 5											
.0000	.16377-02	-.15416-02	.00000	-.73455-02	.11959+05	-.11959+05	-.27936+05	-.35112+05	.00000	.00000	
.0438	.19735-02	-.14039-02	.00000	-.78235-02	.23991+03	-.23991+03	-.20954+05	-.21097+05	.00000	.00000	
.0875	.23131-02	-.12711-02	.00000	-.76581-02	-.27423+04	.27423+04	-.11227+05	-.95821+04	.00000	.00000	
.0875	.23132-02	-.12711-02	.00000	-.76581-02	-.27429+04	.27429+04	-.11226+05	-.95802+04	.00000	.00000	
.1313	.26432-02	-.11430-02	.00000	-.74511-02	.13880+04	.13880+04	-.49842+03	.33439+03	.00000	.00000	
.1750	.29677-02	-.10196-02	.00000	-.74034-02	.73867+01	-.73877+01	.10067+05	.10062+05	.00000	.00000	

MAIN SHELL PART NO 6											
.0000	.21571-02	-.26895-02	.00000	-.62231-02	-.80819+05	.50967+04	-.50039+05	-.24264+05	.00000	.00000	
.0194	.22656-02	-.26514-02	.00000	-.50116-02	-.74398+05	.13241+04	-.46972+05	-.25050+05	.00000	.00000	
.0387	.23524-02	-.26122-02	.00000	-.39650-02	.70058+05	-.56644+04	-.45103+05	-.25785+05	.00000	.00000	
.0387	.23524-02	-.26122-02	.00000	-.39650-02	.70058+05	-.56644+04	-.45104+05	-.25785+05	.00000	.00000	
.0581	.24199-02	-.25720-02	.00000	-.30190-02	.67828+05	.78946+04	-.44375+05	-.26395+05	.00000	.00000	
.0775	.24696-02	-.25306-02	.00000	-.21089-02	.67711+05	.80115+04	-.44752+05	-.26843+05	.00000	.00000	
.0775	.24696-02	-.25306-02	.00000	-.21089-02	.67711+05	.80115+04	-.44753+05	-.26843+05	.00000	.00000	
.0969	.25015-02	-.24779-02	.00000	-.11703-02	.69086+05	.60364+04	-.46228+05	-.27133+05	.00000	.00000	
.1162	.25144-02	-.24438-02	.00000	-.13971-03	.73707+05	-.20149+04	-.48817+05	-.27310+05	.00000	.00000	
.1162	.25144-02	-.24438-02	.00000	-.13971-03	.73707+05	-.20150+04	-.48818+05	-.27310+05	.00000	.00000	
.1356	.25059-02	-.23982-02	.00000	.10444-02	-.79703+05	.39811+04	-.52564+05	-.27458+05	.00000	.00000	
.1550	.24725-02	-.23509-02	.00000	.24410-02	-.87573+05	.11851+05	-.57529+05	-.27702+05	.00000	.00000	

BRANCH SHELL PART NO 7											
.0000	-.23509-02	-.24725-02	.00000	.24410-02	.28932+05	.15634+05	-.38648+05	-.27856+05	.00000	.00000	
.0292	-.24378-02	-.23706-02	.00000	.35057-02	.28661+05	.16849+05	-.38920+05	-.29070+05	.00000	.00000	
.0585	-.25563-02	-.22677-02	.00000	.46029-02	.28366+05	.18168+05	-.39214+05	-.30390+05	.00000	.00000	
.0585	-.25563-02	-.22677-02	.00000	.46029-02	.28366+05	.18168+05	-.39214+05	-.30390+05	.00000	.00000	
.0877	-.27075-02	-.21637-02	.00000	.57353-02	.28045+05	.19605+05	-.39535+05	-.31826+05	.00000	.00000	
.1170	-.28922-02	-.20584-02	.00000	.69063-02	.27695+05	.21172+05	-.39886+05	-.33394+05	.00000	.00000	

BRANCH SHELL PART NO 8											
.0000	-.20584-02	-.28922-02	.00000	.69063-02	.18475+05	.18475+05	-.41204+05	-.30119+05	.00000	.00000	
.0325	-.22937-02	.30121-02	.00000	.74985-02	.88150+04	.88150+04	-.31350+05	-.26061+05	.00000	.00000	
.0650	-.25422-02	.31295-02	.00000	.77538-02	.32104+04	.32104+04	-.22320+05	-.20393+05	.00000	.00000	
.0650	-.25422-02	.31295-02	.00000	.77538-02	.32104+04	.32104+04	-.22320+05	-.20393+05	.00000	.00000	
.0975	-.27957-02	.32444-02	.00000	.78302-02	-.62513+03	.62513+03	-.14047+05	-.13672+05	.00000	.00000	
.1300	-.30504-02	.33567-02	.00000	.78388-02	-.97656-02	-.97656-02	-.63281+04	-.63281+04	.00000	.00000	

MAIN SHELL PART NO 9											
.0000	.24725-02	-.23509-02	.00000	.24410-02	-.65290+05	-.10432+05	-.50844+05	-.34387+05	.00000	.00000	
.0787	.22049-02	-.21457-02	.00000	.37367-02	.35289+05	-.40433+05	-.52914+05	-.54457+05	.00000	.00000	
.1575	.19468-02	-.19199-02	.00000	.25997-02	.24672+05	.51051+05	-.60490+05	-.68403+05	.00000	.00000	
.1575	.19468-02	-.19199-02	.00000	.25997-02	.24672+05	.51051+05	-.60489+05	-.68403+05	.00000	.00000	
.2362	.18103-02	-.16753-02	.00000	.86298-03	.24461+05	-.51262+05	-.67948+05	-.75989+05	.00000	.00000	
.3150	.18032-02	-.14147-02	.00000	-.60252-03	-.28249+05	-.47473+05	-.73196+05	-.78964+05	.00000	.00000	
.3150	.18032-02	-.14147-02	.00000	-.60247-03	-.28250+05	-.47473+05	-.73197+05	-.78963+05	.00000	.00000	

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.3937	.18911-02	.11405-02	.00000	.15430-02	.32463+05	.43260+05	.76085+05	.79324+05	.00000	.00000
.4725	.20337-02	.85432-03	.00000	.20116-02	.35639+05	.40083+05	.77245+05	.78579+05	.00000	.00000
.4725	.20337-02	.85432-03	.00000	.20115-02	.35638+05	.40084+05	.77245+05	.78579+05	.00000	.00000
.5512	.21996-02	.55690-03	.00000	.21607-02	.37540+05	.38183+05	.77430+05	.77623+05	.00000	.00000
.6300	.23695-02	.24850-03	.00000	.21347-02	.38460+05	.37262+05	.77228+05	.76869+05	.00000	.00000
.6300	.23695-02	.24850-03	.00000	.21347-02	.38460+05	.37263+05	.77228+05	.76869+05	.00000	.00000
.7087	.25338-02	.70957-04	.00000	.20326-02	.38790+05	.36932+05	.77003+05	.76446+05	.00000	.00000
.7875	.26891-02	.40166-03	.00000	.19102-02	.38800+05	.36922+05	.76926+05	.76363+05	.00000	.00000
.7875	.26891-02	.40166-03	.00000	.19102-02	.38800+05	.36922+05	.76926+05	.76363+05	.00000	.00000
.8662	.28351-02	.74386-03	.00000	.18019-02	.38559+05	.37164+05	.77020+05	.76601+05	.00000	.00000
.9450	.29743-02	.10978-02	.00000	.17471-02	.37928+05	.37794+05	.77176+05	.77136+05	.00000	.00000
.9450	.29743-02	.10978-02	.00000	.17471-02	.37928+05	.37794+05	.77176+05	.77136+05	.00000	.00000
1.0237	.31134-02	.14635-02	.00000	.18137-02	.36626+05	.39096+05	.77140+05	.77881+05	.00000	.00000
1.1025	.32659-02	.18410-02	.00000	.21092-02	.34374+05	.41349+05	.76486+05	.78578+05	.00000	.00000
1.1025	.32659-02	.18410-02	.00000	.21092-02	.34375+05	.41347+05	.76486+05	.78578+05	.00000	.00000
1.1812	.34550-02	.22297-02	.00000	.27631-02	.31196+05	.44527+05	.74643+05	.78642+05	.00000	.00000
1.2600	.37129-02	.26285-02	.00000	.27631-02	.31196+05	.44527+05	.74643+05	.78642+05	.00000	.00000
1.2600	.37129-02	.26285-02	.00000	.27631-02	.31196+05	.44527+05	.74643+05	.78642+05	.00000	.00000
1.3387	.40716-02	.30357-02	.00000	.38577-02	.27905+05	.47818+05	.71057+05	.77030+05	.00000	.00000
1.4175	.45395-02	.34489-02	.00000	.38571-02	.27907+05	.47816+05	.71058+05	.77031+05	.00000	.00000
1.4175	.45395-02	.34489-02	.00000	.38571-02	.27907+05	.47816+05	.71058+05	.77031+05	.00000	.00000
1.4962	.50551-02	.38663-02	.00000	.52802-02	.26778+05	.48944+05	.65624+05	.72274+05	.00000	.00000
1.5750	.54199-02	.42887-02	.00000	.52802-02	.26778+05	.48944+05	.65624+05	.72274+05	.00000	.00000
1.5750	.54199-02	.42887-02	.00000	.52802-02	.26778+05	.48944+05	.65624+05	.72274+05	.00000	.00000

BRANCH SHELL PART NO 10

.0000	.42887-02	.54198-02	.00000	.22058-02	.45265+04	.40064+04	.39367+05	.34843+05	.00000	.00000
.0297	.43545-02	.52243-02	.00000	.22184-02	.35361+04	.31299+04	.40357+05	.35720+05	.00000	.00000
.0595	.44207-02	.50274-02	.00000	.22330-02	.24588+04	.21764+04	.41434+05	.36674+05	.00000	.00000
.0595	.44207-02	.50274-02	.00000	.22330-02	.24589+04	.21764+04	.41434+05	.36674+05	.00000	.00000
.0892	.44874-02	.48266-02	.00000	.22500-02	.12842+04	.11366+04	.42609+05	.37713+05	.00000	.00000
.1190	.45546-02	.46290-02	.00000	.22695-02	.39063+02	.97656-02	.43893+05	.38850+05	.00000	.00000

MAIN SHELL PART NO 11

.0000	.54198-02	.42887-02	.00000	.22058-02	.88302+05	.12580+05	.62316+05	.32051+05	.00000	.00000
.0483	.54457-02	.45538-02	.00000	.78132-03	.62181+05	.13541+05	.56917+05	.42325+05	.00000	.00000
.0967	.53728-02	.48266-02	.00000	.19979-02	.44588+05	.31135+05	.56505+05	.52469+05	.00000	.00000
.1450	.52709-02	.51079-02	.00000	.20735-02	.34006+05	.41717+05	.58887+05	.61200+05	.00000	.00000
.1450	.52709-02	.51079-02	.00000	.20737-02	.34007+05	.41716+05	.58887+05	.61200+05	.00000	.00000
.1933	.51826-02	.53978-02	.00000	.15065-02	.28679+05	.47043+05	.62491+05	.68000+05	.00000	.00000
.2417	.51297-02	.56960-02	.00000	.65651-03	.26949+05	.48773+05	.66290+05	.72837+05	.00000	.00000
.2900	.51198-02	.60021-02	.00000	.23939-03	.27434+05	.48288+05	.69696+05	.75952+05	.00000	.00000
.2900	.51198-02	.60021-02	.00000	.23937-03	.27435+05	.48287+05	.69696+05	.75952+05	.00000	.00000
.3383	.51513-02	.63154-02	.00000	.10431-02	.29087+05	.46636+05	.72440+05	.77705+05	.00000	.00000
.3867	.52181-02	.66355-02	.00000	.16893-02	.31178+05	.44544+05	.74465+05	.78475+05	.00000	.00000
.4350	.53118-02	.69621-02	.00000	.21608-02	.33254+05	.42468+05	.75840+05	.78604+05	.00000	.00000
.4350	.53118-02	.69621-02	.00000	.21608-02	.33254+05	.42468+05	.75840+05	.78604+05	.00000	.00000
.4833	.54243-02	.72948-02	.00000	.24692-02	.35069+05	.40654+05	.76694+05	.78370+05	.00000	.00000



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.5317	.55483-02	.76334-02	.00000	.26408-02	.36517+05	.39205+05	.77174+05	.77981+05	.00000	.00000
.5800	.56779-02	.79780-02	.00000	.27068-02	.37581+05	.38142+05	.77417+05	.77586+05	.00000	.00000
.5800	.56779-02	.79780-02	.00000	.27067-02	.37582+05	.38141+05	.77418+05	.77585+05	.00000	.00000
.6283	.58087-02	.83284-02	.00000	.26982-02	.38283+05	.37440+05	.77535+05	.77282+05	.00000	.00000
.6767	.59380-02	.86847-02	.00000	.26445-02	.38649+05	.37074+05	.77602+05	.77129+05	.00000	.00000
.7250	.60641-02	.90470-02	.00000	.25730-02	.38693+05	.37030+05	.77659+05	.77160+05	.00000	.00000
.7250	.60641-02	.90470-02	.00000	.25730-02	.38692+05	.37030+05	.77659+05	.77160+05	.00000	.00000
.7733	.61869-02	.94154-02	.00000	.25118-02	.38400+05	.37322+05	.77704+05	.77381+05	.00000	.00000
.8217	.63075-02	.97899-02	.00000	.24914-02	.37729+05	.37993+05	.77697+05	.77776+05	.00000	.00000
.8700	.64289-02	.10171-01	.00000	.25473-02	.36620+05	.39103+05	.77551+05	.78296+05	.00000	.00000
.8700	.64289-02	.10171-01	.00000	.25473-02	.36620+05	.39102+05	.77551+05	.78296+05	.00000	.00000
.9183	.65557-02	.10557-01	.00000	.27206-02	.35015+05	.40708+05	.77143+05	.78851+05	.00000	.00000
.9667	.66945-02	.10950-01	.00000	.30565-02	.32894+05	.42829+05	.76311+05	.79291+05	.00000	.00000
1.0150	.68545-02	.11349-01	.00000	.35989-02	.30326+05	.45397+05	.74871+05	.79393+05	.00000	.00000
1.0150	.68545-02	.11349-01	.00000	.35990-02	.30325+05	.45397+05	.74871+05	.79393+05	.00000	.00000
1.0633	.70463-02	.11754-01	.00000	.43802-02	.27532+05	.48191+05	.72646+05	.78844+05	.00000	.00000
1.1117	.72818-02	.12163-01	.00000	.54038-02	.24965+05	.50757+05	.69509+05	.77247+05	.00000	.00000
1.1600	.75718-02	.12577-01	.00000	.66202-02	.23392+05	.52330+05	.65454+05	.74135+05	.00000	.00000
1.1600	.75718-02	.12577-01	.00000	.66201-02	.23392+05	.52330+05	.65454+05	.74135+05	.00000	.00000
1.2083	.79228-02	.12995-01	.00000	.78949-02	.23968+05	.51754+05	.60692+05	.69028+05	.00000	.00000
1.2567	.83319-02	.13415-01	.00000	.89706-02	.26276+05	.47447+05	.55776+05	.61528+05	.00000	.00000
1.3050	.87801-02	.13838-01	.00000	.94282-02	.38297+05	.37426+05	.51746+05	.51485+05	.00000	.00000
1.3050	.87801-02	.13838-01	.00000	.94282-02	.38297+05	.37426+05	.51746+05	.51485+05	.00000	.00000
1.3533	.92235-02	.14263-01	.00000	.86538-02	.56265+05	.19457+05	.50269+05	.39226+05	.00000	.00000
1.4017	.95837-02	.14691-01	.00000	.86271-02	.84341+05	.86184+05	.53754+05	.25866+05	.00000	.00000
1.4500	.97377-02	.15123-01	.00000	.51604-04	.12404+06	.48314+05	.65361+05	.13676+05	.00000	.00000

MAIN SHELL PART NO 12

.0000	.15473-01	.91720-02	.00000	.51621-04	.12286+06	.49493+05	.65018+05	.13334+05	.00000	.00000
.0291	.15430-01	.94393-02	.00000	.23109-02	.51414+05	.42501+04	.43931+05	.28682+05	.00000	.00000
.0291	.15430-01	.94393-02	.00000	.23109-02	.51414+05	.42501+04	.43931+05	.28682+05	.00000	.00000
.0581	.15353-01	.97173-02	.00000	.28762-02	.28488+05	.59799+04	.38498+05	.34221+05	.00000	.00000
.0581	.15354-01	.97173-02	.00000	.28760-02	.28488+05	.59799+04	.38498+05	.34221+05	.00000	.00000
.0872	.15267-01	.10003-01	.00000	.30617-02	.17990+05	.88446+04	.37192+05	.37815+05	.00000	.00000
.0872	.15267-01	.10003-01	.00000	.30617-02	.17990+05	.88446+04	.37192+05	.37815+05	.00000	.00000
.1163	.15177-01	.10294-01	.00000	.31244-02	.11935+05	.96885+04	.37426+05	.40952+05	.00000	.00000
.1163	.15177-01	.10294-01	.00000	.31244-02	.11935+05	.96885+04	.37426+05	.40952+05	.00000	.00000
.1453	.15086-01	.10590-01	.00000	.31359-02	.77699+04	.99722+04	.38363+05	.44026+05	.00000	.00000

MAIN SHELL PART NO 13

.0000	.87569-02	.16218-01	.00000	.31359-02	.38616+05	.86037+05	.26113+05	.63508+05	.00000	.00000
.0168	.87150-02	.16381-01	.00000	.18742-02	.34939+05	.82360+05	.28213+05	.63402+05	.00000	.00000
.0336	.86936-02	.16543-01	.00000	.68974-03	.31204+05	.78625+05	.29842+05	.62791+05	.00000	.00000
.0503	.86914-02	.16705-01	.00000	.41630-03	.27424+05	.74846+05	.31028+05	.61709+05	.00000	.00000
.0503	.86914-02	.16705-01	.00000	.41631-03	.27424+05	.74846+05	.31028+05	.61709+05	.00000	.00000
.0671	.87071-02	.16868-01	.00000	.14431-02	.23603+05	.71024+05	.31801+05	.60189+05	.00000	.00000
.0839	.87394-02	.17030-01	.00000	.23896-02	.19729+05	.67150+05	.32196+05	.58259+05	.00000	.00000



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1007	.87869-02	.17192-01	.00000	-.32547-02	.15781+05	-.63202+05	-.32251+05	-.55946+05	.00000	.00000
1007	.87869-02	.17192-01	.00000	-.32547-02	.15782+05	-.63203+05	-.32251+05	-.55946+05	.00000	.00000
1174	.88482-02	.17354-01	.00000	-.40364-02	.11731+05	-.59152+05	-.32009+05	-.53214+05	.00000	.00000
1342	.89218-02	.17451-01	.00000	-.47321-02	.75347+04	-.54956+05	-.31516+05	-.50263+05	.00000	.00000
1510	.90064-02	.17676-01	.00000	-.53384-02	.31465+04	-.50567+05	-.30820+05	-.46934+05	.00000	.00000
1510	.90064-02	.17676-01	.00000	-.53384-02	.31472+04	-.50568+05	-.30820+05	-.46934+05	.00000	.00000
1678	.91004-02	.17837-01	.00000	-.58508-02	.14878+04	-.45933+05	-.29975+05	-.43308+05	.00000	.00000
1846	.92022-02	.17997-01	.00000	-.62633-02	.64315+04	-.40990+05	-.29038+05	-.39405+05	.00000	.00000
2013	.93100-02	.18157-01	.00000	-.65690-02	.11750+05	-.35671+05	-.28069+05	-.35246+05	.00000	.00000
2013	.93100-02	.18157-01	.00000	-.65690-02	.11750+05	-.35672+05	-.28069+05	-.35246+05	.00000	.00000
2181	.94220-02	.18316-01	.00000	-.67592-02	.17513+05	-.29908+05	-.27135+05	-.30854+05	.00000	.00000
2349	.95361-02	.18474-01	.00000	-.68239-02	.23794+05	-.23627+05	-.26305+05	-.26255+05	.00000	.00000
2517	.96502-02	.18632-01	.00000	-.67516-02	.30669+05	-.16752+05	-.25655+05	-.21480+05	.00000	.00000
2517	.96502-02	.18632-01	.00000	-.67516-02	.30668+05	-.16753+05	-.25654+05	-.21480+05	.00000	.00000
2684	.97618-02	.18789-01	.00000	-.65290-02	.38208+05	-.92129+04	-.25262+05	-.16563+05	.00000	.00000
2852	.98684-02	.18946-01	.00000	-.61417-02	.46488+05	-.93294+03	-.25212+05	-.11546+05	.00000	.00000
3020	.99669-02	.19103-01	.00000	-.55732-02	.55577+05	.81559+04	-.25595+05	-.64755+04	.00000	.00000
MAIN SHELL PART NO 14										
1.5708	.99670-02	.19103-01	.00000	-.55733-02	.39260+05	.14562+05	-.20700+05	-.45537+04	.00000	.00000
1.6140	.10846-01	.18755-01	.00000	-.53705-02	.41880+05	.16583+05	-.20199+05	-.20334+04	.00000	.00000
1.6572	.11706-01	.18370-01	.00000	-.51481-02	.44368+05	.18486+05	-.19684+05	.35543+03	.00000	.00000
1.7004	.12547-01	.17947-01	.00000	-.49050-02	.46727+05	.20269+05	-.19155+05	.26100+04	.00000	.00000
1.7004	.12547-01	.17947-01	.00000	-.49050-02	.46727+05	.20269+05	-.19155+05	.26100+04	.00000	.00000
1.7436	.13367-01	.17490-01	.00000	-.46401-02	.48957+05	.21929+05	-.18609+05	.47259+04	.00000	.00000
1.7868	.14164-01	.16998-01	.00000	-.43521-02	.51058+05	.23462+05	-.18047+05	.66973+04	.00000	.00000
1.8300	.14937-01	.16475-01	.00000	-.40392-02	.53026+05	.24859+05	-.17466+05	.85164+04	.00000	.00000
1.8300	.14937-01	.16475-01	.00000	-.40393-02	.53026+05	.24859+05	-.17466+05	.85165+04	.00000	.00000
1.8732	.15684-01	.15920-01	.00000	-.36994-02	.54855+05	.26110+05	-.16866+05	.10174+05	.00000	.00000
1.9164	.16403-01	.15336-01	.00000	-.33311-02	.56538+05	.27201+05	-.16248+05	.11656+05	.00000	.00000
1.9596	.17093-01	.14726-01	.00000	-.29312-02	.58063+05	.28117+05	-.15613+05	.12950+05	.00000	.00000
1.9596	.17093-01	.14726-01	.00000	-.29312-02	.58063+05	.28117+05	-.15613+05	.12950+05	.00000	.00000
2.0028	.17751-01	.14089-01	.00000	-.24974-02	.59418+05	.28837+05	-.14961+05	.14037+05	.00000	.00000
2.0460	.18378-01	.13430-01	.00000	-.20266-02	.60585+05	.29337+05	-.14295+05	.14894+05	.00000	.00000
2.0892	.18969-01	.12749-01	.00000	-.15159-02	.61544+05	.29591+05	-.13619+05	.15495+05	.00000	.00000
2.0892	.18969-01	.12749-01	.00000	-.15160-02	.61544+05	.29591+05	-.13620+05	.15495+05	.00000	.00000
2.1324	.19524-01	.12050-01	.00000	-.96224-03	.62272+05	.29565+05	-.12940+05	.15810+05	.00000	.00000
2.1756	.20640-01	.11335-01	.00000	-.36233-03	.62740+05	.29221+05	-.12266+05	.15801+05	.00000	.00000
2.2188	.20515-01	.10607-01	.00000	-.28658-03	.62914+05	.28516+05	-.11607+05	.15424+05	.00000	.00000
2.2188	.20515-01	.10607-01	.00000	-.28638-03	.62914+05	.28516+05	-.11607+05	.15424+05	.00000	.00000
2.2620	.20945-01	.98684-02	.00000	-.98661-03	.62754+05	.27399+05	-.10979+05	.14627+05	.00000	.00000
2.3052	.21329-01	.91237-02	.00000	-.17395-02	.62212+05	.25811+05	-.10401+05	.13351+05	.00000	.00000
2.3484	.21661-01	.83764-02	.00000	-.25446-02	.61230+05	.23686+05	-.98984+04	.11524+05	.00000	.00000
2.3484	.21661-01	.83764-02	.00000	-.25442-02	.61231+05	.23686+05	-.98984+04	.11524+05	.00000	.00000
2.3916	.21938-01	.76308-02	.00000	-.33985-02	.59740+05	.20945+05	-.95004+04	.90660+04	.00000	.00000
2.4348	.22156-01	.68917-02	.00000	-.42949-02	.57651+05	.17495+05	-.92456+04	.58842+04	.00000	.00000
2.4780	.22309-01	.61647-02	.00000	-.52196-02	.54851+05	.13227+05	-.91776+04	.18750+04	.00000	.00000
2.4780	.22309-01	.61649-02	.00000	-.52186-02	.54850+05	.13230+05	-.91813+04	.18737+04	.00000	.00000



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2.5212	.22391-01	.54562-02	.00000	.61483-02	-.51183+05	.80043+04	-.93477+04	-.30759+04	.00000	.00000
2.5644	.22397-01	.47731-02	.00000	.70448-02	-.46439+05	.16458+04	-.97993+04	-.90831+04	.00000	.00000
2.6076	.22322-01	.41235-02	.00000	.78471-02	-.40313+05	-.60846+04	-.10580+05	-.16259+05	.00000	.00000
2.6076	.22322-01	.41240-02	.00000	.78441-02	-.40303+05	-.60804+04	-.10593+05	-.16268+05	.00000	.00000
2.6508	.22166-01	.35174-02	.00000	.84554-02	-.32331+05	-.15530+05	-.11725+05	-.24697+05	.00000	.00000
2.6940	.21932-01	.29642-02	.00000	.87298-02	-.22136+05	-.26950+05	-.13328+05	-.34345+05	.00000	.00000
2.7372	.21638-01	.24762-02	.00000	.84316-02	-.83234+04	-.41386+05	-.15176+05	-.45137+05	.00000	.00000
2.7372	.21636-01	.24779-02	.00000	.84183-02	-.82280+04	-.41408+05	-.15234+05	-.45198+05	.00000	.00000
2.7804	.21321-01	.20690-02	.00000	.71513-02	.10951+05	-.60160+05	-.17119+05	-.56653+05	.00000	.00000
2.8236	.21065-01	.17540-02	.00000	.42765-02	.37958+05	-.85102+05	-.18763+05	-.67493+05	.00200	.00000
2.8668	.21026-01	.15486-02	.00000	-.12630-02	.76630+05	-.11937+06	-.19850+05	-.74794+05	.00000	.00000
MAIN SHELL PART NO 15										
.0000	.42059-02	.20648-01	.00000	-.13049-02	.31289+05	-.42311+05	-.32944+05	-.55024+05	.00000	.00000
.1300	.44754-02	.21990-01	.00000	-.23083-02	-.96130+04	-.14085+04	-.32167+05	-.29706+05	.00000	.00000
.1300	.44754-02	.21990-01	.00000	-.23083-02	-.96130+04	-.14085+04	-.32167+05	-.29706+05	.00000	.00000
.2600	.47302-02	.23310-01	.00000	-.14987-02	-.18466+05	-.74446+04	-.22491+05	-.14718+05	.00000	.00000
.2600	.47302-02	.23310-01	.00000	-.14981-02	-.18487+05	.74651+04	-.22497+05	-.14712+05	.00000	.00000
.3900	.48622-02	.24615-01	.00000	-.58236-03	-.14852+05	.38306+04	-.15017+05	-.94124+04	.00000	.00000
.3900	.48622-02	.24615-01	.00000	-.58174-03	-.14872+05	.38508+04	-.15024+05	-.94067+04	.00000	.00000
.5200	.48994-02	.25913-01	.00000	-.63695-04	-.94238+04	-.15977+04	-.11585+05	-.92374+04	.00000	.00000
.5200	.48994-02	.25913-01	.00000	-.63117-04	-.94439+04	-.15777+04	-.11592+05	-.92321+04	.00000	.00000
.6500	.48949-02	.27211-01	.00000	.79982-04	-.54919+04	-.55296+04	-.10623+05	-.10634+05	.00000	.00000
.6500	.48949-02	.27211-01	.00000	.80539-04	-.55122+04	-.55093+04	-.10629+05	-.10629+05	.00000	.00000
.7800	.48892-02	.28509-01	.00000	-.26463-04	-.29688+04	-.80527+04	-.10141+05	-.11667+05	.00000	.00000
.7800	.48892-02	.28509-01	.00000	-.25923-04	-.29892+04	-.80323+04	-.10148+05	-.11661+05	.00000	.00000
.9100	.49085-02	.29807-01	.00000	-.28981-03	-.15747+04	-.94468+04	-.87899+04	-.11152+05	.00000	.00000
.9100	.49085-02	.29807-01	.00000	-.28927-03	-.15952+04	-.94263+04	-.87968+04	-.11146+05	.00000	.00000
1.0400	.49657-02	.31102-01	.00000	-.57450-03	-.29270+04	-.80945+04	-.64263+04	-.79765+04	.00000	.00000
1.0400	.49657-02	.31102-01	.00000	-.57398-03	-.29478+04	-.80737+04	-.64330+04	-.79708+04	.00000	.00000
1.1700	.50432-02	.32392-01	.00000	-.50709-03	-.11456+05	.43457+03	-.52355+04	-.16683+04	.00000	.00000
1.1700	.50431-02	.32392-01	.00000	-.50655-03	-.11476+05	.45452+03	-.52425+04	-.16634+04	.00000	.00000
1.3000	.50484-02	.33677-01	.00000	.70474-03	-.32700+05	.21679+05	-.11356+05	.49572+04	.00000	.00000
MAIN SHELL PART NO 16										
.0000	.33677-01	-.50483-02	.00000	.70541-03	-.13055+05	.75294+04	-.20487+04	-.27035+04	.00000	.00000
.0673	.33620-01	-.43763-02	.00000	.96254-03	-.97486+04	.37157+04	.32633+03	-.56748+04	.00000	.00000
.1347	.33549-01	-.37058-02	.00000	.11529-02	-.64055+04	-.18111+03	.25355+04	-.87990+04	.00000	.00000
.1347	.33549-01	-.37058-02	.00000	.11528-02	-.64051+04	-.18143+03	.25353+04	-.87988+04	.00000	.00000
.2020	.33467-01	-.30355-02	.00000	.12660-02	-.31661+04	-.39601+04	.44904+04	-.12113+05	.00000	.00000
.2693	.33380-01	-.23641-02	.00000	.12983-02	-.31589+03	-.71176+04	.60623+04	-.15777+05	.00000	.00000
.2693	.33380-01	-.23641-02	.00000	.12982-02	-.31584+03	-.71177+04	.60622+04	-.15776+05	.00000	.00000
.3367	.33294-01	-.16898-02	.00000	.12731-02	-.14659+04	-.81412+04	.70827+04	-.20551+05	.00000	.00000
.4040	.33207-01	-.10124-02	.00000	.13373-02	-.10172+02	-.29883+01	.76167+04	-.31543+05	.00000	.00000

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DATE 17 JAN 74
PART NO. 252574
PREPARED BY M. K. 19570

CALC. NO. 26263 SHEET NO. 9-46
MODEL NO. 1/4 W. V.M.
CHECKED BY _____

9.3 SHELL ANALYSIS

DOME/BEARING JOURNAL JUNCTION, OUTBOARD END

CHECK LOCAL REINFORCED AREA

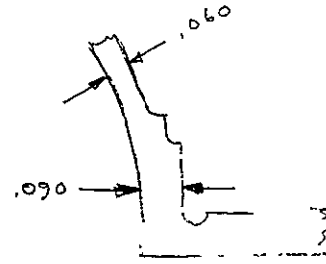
$$a_o = 1.125 \quad a = 1.08$$

$$t = .090$$

$$\text{FOR } b = \frac{1}{2} a \quad R_s = 2a = 2.16$$

$$R_c = .297 - .0625 = 0.234$$

$$t_c = 0.125$$



$$p = \frac{R_c}{R_s} \left(\frac{R_s}{t_s} \right)^{1/2} = \frac{.234}{(2.16 \times .090)^{1/2}} = .553$$

.174 .44

$$\frac{t_c}{t_s} = \frac{.125}{.090} = 1.39$$

$$SCF = 1.8 \quad (\text{REF 8, FIG 3.6})$$

$$f_{max} = 1.8 \times \frac{1250 \times 2.160}{2 \times .090} = 27,000 \text{ psi - OPERATING}$$

$$= 60,500 \text{ psi - BURST}$$

$$F_{CORR} = 35,000 \text{ psi} \quad (1200^\circ\text{F} @ 20,000 \text{ hrs AND } 2\%)$$

$$F_{T0} = 140,000 \text{ psi} \quad (1200^\circ\text{F})$$

$$M.S. = \frac{35,000}{27,000} - 1 =$$

0.30



DATE 8 JAN 74
PART NO. 852574
PREPARED BY MOTOMOTO

CALC. NO. C 6263 SHEET NO. 9-47
MODEL NO. 1/4 W.V.M.
CHECKED BY _____

9.4 BEARING JOURNAL DEFLECTION

VIBRATORY LOAD = 87. G'S (REF. PAGE 7-11)

$$\begin{aligned}\text{LOAD, } P &= \frac{1}{2} \text{ DISPLACEMENT WT.} \times \text{LOAD FACTOR} \\ &= .47 \times 87 = 40.9 \text{ LBS.}\end{aligned}$$

ASSUME LOAD ACTS AT $\frac{1}{3} L$ FROM FREE END

$$\delta = \frac{PL^3}{3EI}$$

$$L = 1.0 \text{ IN.}$$

$$I = \frac{\pi}{64} (.625^4 - .381^4) = 6.46 \times 10^{-5} \text{ IN}^4$$

$$\begin{aligned}\delta &= \frac{40.9 \times 1.0^3}{3 \times 30 \times 10^6 \times 6.46 \times 10^{-5}} \\ &= 0.000070 \text{ IN.}\end{aligned}$$

SINCE $\delta < .0002$ CLEARANCE, THIS IS O.K.



AIRESEARCH MANUFACTURING COMPANY
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SECTION 10
COLD-END DISPLACER
STRESS ANALYSIS

DATE 17 JAN 74
PART NO. 852546
PREPARED BY MORINOTO

CALC. NO. C 6263 SHEET NO. 10-1
MODEL NO. 1/4 W. V.M.
CHECKED BY _____

10. COLD END DISPLACER

- 10.1 TASKS
- 10.2 BUCKLING ANALYSIS
- 10.3 SHELL ANALYSIS
- 10.4 DISPLACEMENT AT END



DATE 17 JAN 74
PART NO. 852546
PREPARED BY MARUIMOTO

CALC. NO. C6263 SHEET NO. 10-2
MODEL NO. V4 W.V.M.
CHECKED BY _____

10.1 TASKS

THE ANALYSIS OF THE COLD END DISPLACER CONSISTS OF THE FOLLOWING TASKS:

- DETERMINE EXTERNAL COLLAPSING PRESSURE
- DETERMINE STRESSES AT DOME/CYLINDER JUNCTION
- DETERMINE DISPLACER DEFLECTION AT THE END DUE TO RANDOM VIBRATION LOADING.



DATE 17 JAN 74
 PART NO. 852546
 PREPARED BY MORIMOTO

CALC. NO. C6263 SHEET NO. 10-3
 MODEL NO. 1/4 W V.M.
 CHECKED BY _____

10.2 BUCKLING ANALYSIS

THE METHOD EXPLAINED ON PAGE 9-3 WILL BE USED

$$D_o = 0.3925 \text{ (MIN.)} \quad P_I = .3720 \text{ (MAX.)}$$

$$t = 0.010 \text{ (MIN.)} \quad R_m = .1911$$

$$b = 0.024 \text{ IN. (MIN.)}$$

$$d = 0.040 \text{ (MIN.)}$$

$$L_f = \text{RING SPACING} = 0.49 + 0.024 = 0.514 \text{ IN.}$$

$$L = 5.034 \text{ IN.}$$

$$A_f = .024 \times .040 = 0.96 \times 10^{-3} \text{ IN}^2$$

$$I_f = \frac{.024 \times .040^3}{12} = .128 \times 10^{-6} \text{ IN}^4$$

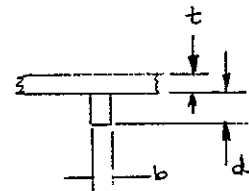
$$e = \frac{1}{2} (.010 + .040) = 0.025 \text{ IN.}$$

$$\bar{e} = \frac{.025 \times .96 \times 10^{-3}}{.96 \times 10^{-3} + .025 \times .514} = 0.00174 \text{ IN.}$$

$$F = \frac{12(1-.30^2)}{.514 \times .010^3} \left[.128 \times 10^{-6} + .96 \times 10^{-3} (0.025 - 0.00174)^2 \right]$$

$$+ \left(1 + 12 \times \frac{.00174^2}{.010^2} \right) - 1$$

$$= 14.1$$



DATE 17 JAN 74
 PART NO. 852546
 PREPARED BY MORIMOTO

CALC. NO. C6263 SHEET NO. 10-4
 MODEL NO. 1/4 W. V.M.
 CHECKED BY _____

10.2 BUCKLING ANALYSIS

$$Z = \left(\frac{5.034}{.1911} \right) \left(\frac{5.034}{.0101} \right) (1-.30)^K = 12,600.$$

$C_p = 800.$ FROM FIG. 7, p 129, REF. 5

$$P = \frac{800 \times 29.8 \times 10^6 \times .010^3 \times \pi^2}{12 (1-.30) \times .1911 \times 5.034^2} = \underline{\underline{4,450. PSI}}$$

$$M.S. = \frac{4450.}{1250} - 1 =$$

$$= \frac{4450}{2060} - 1 =$$

$$= \frac{4450.}{2800.} - 1 =$$

2.56
OPER.
1.16
PROOF
0.59
BURST



DATE 20 Apr 72
 PART NO. 852546
 PREPARED BY MASHMOTO

CALC. NO. C6263 SHEET NO. 10-5
 MODEL NO. 1/4 W.V.M.
 CHECKED BY _____

10.3 SHELL ANALYSIS

DOME/CYLINDER JUNCTION

THE METHOD OF REF. 12 (PG 14.7.2-10) WILL BE USED TO ESTIMATE THE STRESS AT THE JUNCTION.

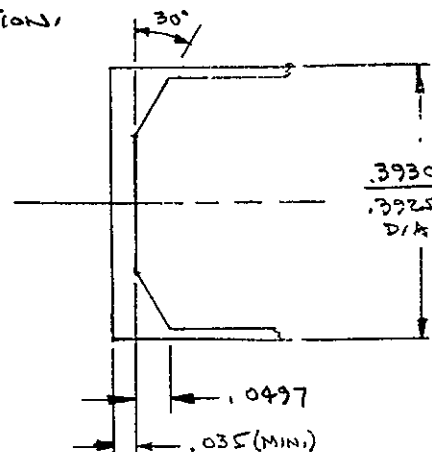
$$t_r (\text{AVE}) = .058 \text{ IN.}$$

$$t_c = .010 \text{ MIN.}$$

$$D = .393 \quad R = .196 \text{ IN.}$$

$$D/t_c = 39.3 \quad t_r/t_c = 5.8$$

$$f'_{cyl} = \frac{K P R}{t_c}$$



$$K = 2.5 \text{ (FROM REF. 12, FIG. 14.7.2.6j)}$$

$$f'_{cyl} = \frac{2.5 \times 2800 \times .196}{.010}$$

$$= 137,000. \text{ PSI}$$

$$f_c = \frac{P R}{2 t} = 27,400. \text{ PSI}$$

$$f_c + f'_{cyl} = 164,000. \text{ PSI}$$

AT -343°F (65°K), F_{TU} FROM INCO 718 IS 240,000. PSI.

$$M.S. = \frac{240,000.}{164,000.} - 1 =$$

$$0.46$$

AT ROOM TEMP., $F_{TU} = 180,000. \text{ PSI}$

$$M.S. = \frac{180}{164} - 1 =$$

$$0.10$$



DATE 17 JAN 74
PART NO. 852546
PREPARED BY MOKIMATO

CALC. NO. 26263 SHEET NO. 10-6
MODEL NO. 1/4 W.V.M.
CHECKED BY _____

10.4 DEFLECTION AT DISPLACER END

$$D_0 = 0.393 \quad t = 0.010$$

$$L = 5.875 \quad (\text{FROM END TO BRG})$$

$$w = \frac{\pi}{4} (0.393^2 - 0.373^2) (0.297) = 0.00357 \text{ LBS/IN.}$$

$$I = \frac{\pi}{64} (0.393^4 - 0.373^4) = 2.21 \times 10^{-4} \text{ IN.}^4$$

$$\begin{aligned} \gamma &= \frac{w L^4}{8 E I} = \frac{0.00357 \times 5.875^4}{8 \times 29.8 \times 10^6 \times 2.21 \times 10^{-4}} \\ &= 80.8 \times 10^{-6} \text{ IN. AT 1 G.} \end{aligned}$$

$$f = \frac{a_n}{2\pi} \left(\frac{E I g}{w L^4} \right)^{1/2}$$

$$= \frac{3.52}{2\pi} \left(\frac{29.8 \times 10^6 \times 2.21 \times 10^{-4} \times 386}{0.00357 \times 5.875^4} \right)^{1/2}$$

$$= 433 \text{ CPS.}$$

RANDOM VIBRATION LOAD AT 433 CPS IS 53.5 G'S (30 RESPONSE).
(SEE NEXT PAGE)

DEFLECTION DUE TO RANDOM VIBRATION LOAD

$$\gamma = 0.00432 \text{ IN.}$$



DATE 17 JAN 74
PART NO. 852546
PREPARED BY MOE HARTO

CALC. NO. C6263 SHEET NO. 10-7
MODEL NO. 1/4 W.V.M.
CHECKED BY _____

10.4 DEFLECTION AT DISPLACED END

VIBRATION LOAD - RANDOM VIBRATION SPECTRUM

ONE SIGMA RESPONSE

$$\ddot{X} = \left(\frac{\pi}{2} \times \text{PSD} \times T \times f_n \right)^{1/2}$$

$$f_n = \underline{433. \text{ cps}}$$

$$\text{PSD} = \underline{0.045 \text{ g/cps}}$$

$$\text{ASSUMING } T = 10.0$$

$$\ddot{X}_1 = \left(\frac{\pi}{2} \times 0.045 \times 10.0 \times 433. \right)^{1/2}$$

$$= \underline{17.5 \text{ g's}}$$

3 SIGMA RESPONSE

$$\ddot{X}_3 = \underline{52.5 \text{ g's}}$$



APPENDIX A
WEIGHT AND C.G. DATA



AIRCRAFT RESEARCH MANUFACTURING COMPANY
OF CALIFORNIA

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S-65701

WEIGHT CALCULATION SHEET

DRAWING NO.	DESCRIPTION	MAT'L	GAGE	NO. REQ	CALCULATIONS	WEIGHT	X	Y	Z	
852545	JACKET Cold End	CRS	.014	1		.01	-7.98		-0.5	
						.16	-4.66		-0.5	
						.03	-1.85		-0.5	
852597	ELBOW	"		1		.02	-2.65		1.05	
852546	DISPLACER ASSY. (PARTIAL)	INCO 718		1		.03	-4.85		-0.5	
						.04	-1.06			
" -15	FILLER	FERRAL		1		.03	-3.70			
852548	RETAINER, REGENERATOR	CRS		1		.03	-1.75			
852550	RING, SUPPORT	"		1		.02	-2.06			
852577-3	BEARING (PARTIAL)	BOEING		1		.15	-1.31			
" -5	" "	PH 13-BH		1		.24	-1.64			
852592	WALL, INNER, COLD REGEN.	INCO 718		1		.02	-4.50			
						.01	-7.16			
852594	DISTRIBUTOR PLATE	"		1		.02	-7.3			
852595	DISTRIBUTOR, FLOW	"		2		.01	-4.7			
852599-1	RING, RETAINING	"		1		.02	-1.85			
						.01	-1.8			
						.10	-1.73			
						.06	-1.57			
						.19	-1.27			
						.01	-1.1			
						.03	-1.22			
						.35	-1.47	-2.56	-0.5	
						.17				
DATE	REV 6-15-73 5-23-73	CUSTOMER	NASA	APPLICATION	SPACE	TOTAL WEIGHT - DRY				LBS.
PROJ. ENGR.		TITLE	VUILLEMIER REFRIGERATION ENGINE 1/4 WAT			TOTAL WEIGHT - WET				LBS.
CALC. BY	NICK LOEWEN					NEXT ASSY.		PAGE 1 OF 10		
						CHANGES		DWG. NO. 851260		

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WEIGHT CALCULATION SHEET

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DATE	CUSTOMER	APPLICATION	TOTAL WEIGHT - DRY	LBS
5-23-73	NASA	SPACE	TOTAL WEIGHT - WET	LBS
PROJ. ENGR.	TITLE	NEXT ASSY.	PAGE	OF
CALC. BY	VUILLEUMIER REFRIGERATION ENGINE 1/4 NATI	CHANGES	DWG. NO.	
NICK LOEWEN			S51269	



AIRSEARCH MANUFACTURING COMPANY
OF CALIFORNIA

74-9896-2
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S-65701

WEIGHT CALCULATION SHEET

DRAWING NO.	DESCRIPTION	MAT'L	GAGE	NO. REQ	CALCULATIONS	WEIGHT	X	Y	Z
852546-1	(PARTIAL) DISPLACER - COLD END	INCO 718	—	1		.02	.62		-0.5
						.01	1.35		
						.01	1.7		
						.01	1.9		
					.09	.04	2.3		
852551	RETAINER - WENT PIN	PH13-8 Mo		1		.05	2.25		
852554	BEARING ASSY "	BOEING		1		.01	2.31		
852555-3	CONNECTING ROD	TITANIUM		1		.02	2.8		
" - 5	"	"		1		.02	3.7		
852556	BEARING "	PH13-8 Mo BOEING		1		.14	4.0		-0.5
852557	SLEEVE	PH13-8 Mo		1		.21	4.0		-0.12
852558	SPACER, BRGS.	"		1		.12	4.0		-0.3
852559	BEARING, MAIN OUTER	BOEING		1		.41	4.0		-1.2
852561	BEARING, MAIN INNER	"		1		.46	4.0		0.8
852562	PLATE, AXIAL BRG	PH13-8 Mo		1		.05	4.0		1.4
852565	AP, CLOSURE JUMP	INCO 718		1		.27	4.0		-2.1
852569-3	CONNECTING ROD - HOT END	TITANIUM		1		.02	4.0		0
" - 5	"	"		1		.02	5.05		0
852570	BEARING, WENT PIN - HOT END	PH13-8 Mo BOEING		1		.01	5.55		0
852571	RETAINER "	PH13-8 Mo		1		.07	5.7		0
852572	SPRING, WAVE, CRANKCASE	17-7 PH		1		.01	4.0		-1.72
852574	DISPLACER (PARTIAL) - HOT END	INCO 718		1		.04	5.6		0
						.12	6.38		0
					2.21	.09	7.35	4.3761	0
DATE 5-23-73		CUSTOMER NASA		APPLICATION SPACE		TOTAL WEIGHT - DRY LBS.			
PROJ. ENGR.		TITLE		VUILLEUMIER REFRIGERATION ENGINE 1/4 WAT		TOTAL WEIGHT - WET LBS.			
CALC. BY NICK LOEWEN						NEXT ASSY.		PAGE 3 OF 10	
						CHANGES		DWG. NO. 851260	

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AIRSEARCH MANUFACTURING COMPANY
OF CALIFORNIA

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S-65701

WEIGHT CALCULATION SHEET

DRAWING NO.	DESCRIPTION	MAT'L	GAGE	NO. REQ.	CALCULATIONS	WEIGHT	X	Y	Z
852574 (CONT.)	DISPLACER, HOT END (PARTIAL)					.02	7.95		0
						.05	8.05		0
					1.41	.09	8.3		0
852575	BEARING	BOEING PH12-BMA		1		.65	6.5		0
852577-3	" (PARTIAL)	BOEING		1		.15	1.12		-0.5
852577-E	" (PARTIAL)	PH13-BMA		1		.14	1.56		-0.5
						.01	2.65		-0.5
						-.01	1.1		-0.5
						-.02	1.2		-0.5
					1.25	.13	.31		-0.5
852580	(PARTIAL) RETAINER, HOT GENERATOR	CRES		1		.03	8.4		0
852583	RING, RETAINING - (PARTIAL)	INCO 718		1		.03	7.94		0
					2	.35	8.12		0
					1.41 3	-.01	8.41		0
852584	FILLER BLOCK, JUMP	ALUM		1		.31	2.4		0
						-.01	3.0		-0.5
						-.02	2.65		-0.5
						-.05	2.05		-0.5
						2.07	5.36		0
						-1.37	4.0		0
						-.02	6.41		0
						.04	8.0		0
						.02	8.15		0
					2.04	.03	8.29	7.12	0
DATE S-23-73		CUSTOMER NASA		APPLICATION SPACE		TOTAL WEIGHT - DRY LBS.			
PROJ. ENGR.		TITLE				TOTAL WEIGHT - WET LBS.			
CALC. BY						NEXT ASSY.		PAGE 4 OF 10	
						CHANGES		DWG. NO. 851260	

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S-65701

WEIGHT CALCULATION SHEET

DRAWING NO.	DESCRIPTION	MAT'L	GAGE	NO. REQ	CALCULATIONS	WEIGHT	X	Y	Z
852584-1	(CONT.)					-.47	6.54		0
					1.52	-.01	7.31		0
852587-1	HOUSING, FILL VALVE	INCO 718		1		.07	1.85		1.12
852588-1	CAP "	"		1		.04	1.6		1.38
852592-1	RING, RETAINING - JUMP	"		1		.28	4.0		-2.0
852602-3	CLAMP-JACKET ASSY.	ALUM		2		.84	6.7		0
852604-1	TUBE ASSY.	"		2		.23	6.7		8.0
852334-1	PIN, WEIST	TUNGSTEN CARBIDE		1		.01	2.31		0
" -2	"	"		1		.02	8.57		0
852590-1	HSQ, INNER-DRIVE MOTOR	INCO 718		1		.11	4.0		3.0
852608-1	DISC.	ALUM		1		.05	4.0		1.75
852607-1	SPACER	"		1		.02	4.0		4.9
852566-1	SHAFT	PH13-8 Mo		1		.02	2.89		1.22
						.70	4.0		1.12
	BOLT, SHAFT	PRE1		1		.02	3.89		-1.34
	HOUSING, OUTER	ALUM		1		.30	4.0		3.6
	COIL, STATOR	COPPER		1		2.0	4.0		3.4
	STACK "	STL		1		3.0	4.0		2.4
	ROTOR	COPPER		1		.84	4.0		3.4
	FIN	"		1		.01	5.96		0
		"				.02	7.16		0
(NOT DETAILED)	HOUSING, JUMP (PARTIAL)	INCO 718		1		.20	.85		0
						.87	1.15		0
					12.06	.18	2.20		0

DATE	S-23-73	CUSTOMER	NASA	APPLICATION	SPACE	TOTAL WEIGHT - DRY	LBS
PROJ. ENGR.		TITLE	VILLEMUR REFRIGERATION ENGINE 1/4 WATT			TOTAL WEIGHT - WET	LBS
CALC. BY	NICK LOEWEN					NEXT ASSY.	PAGE 5 OF 10
						CHANGES	DWG. NO. 851260

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WEIGHT CALCULATION SHEET

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WEIGHT CALCULATION SHEET

DRAWING NO.	DESCRIPTION	MAT'L	GAGE	NO. REQ	CALCULATIONS	WEIGHT	X	Y	Z			
852574	DISPLACER - (PARTIAL) Hot End	Inco 718	—	1		.29	10.52		0			
						.05	9.43					
						.02	10.97					
						.04	12.43					
						.05	12.77					
						.10	13.15					
						.05	13.4					
						.02	13.6					
						.06	14.2					
					1.73	.05	14.95					
852576	BEARINGS	Boeing 4023		1		.18	14.95					
852578	SLEEVE - HT. EXCH.	Inco 718		1		.15	10.6					
						.30	13.25					
						.22	13.8					
						.03	14.08					
						-.04	13.65					
						-.03	12.92					
852579	(PARTIAL) HOUSING, REGENERATOR	Inco 718		1		.01	9.58					
						.11	8.46					
						.24	8.57					
						.01	8.71					
						.36	10.75					
						.01	8.75					
					2.29	.01	12.2	26.7645	0			
DATE	S-23-73	CUSTOMER	NASA	APPLICATION	SPACE	TOTAL WEIGHT - DRY LBS.						
PROJ. ENGR.		TITLE	VUILLEUMIER REFRIGERATION ENGINE 1/4 WATT			TOTAL WEIGHT - WET LBS.						
CALC. BY	NICK LOEWEN					NEXT ASSY.	PAGE 7 OF 10					
						CHANGES	DWG. NO. 851260					

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WEIGHT CALCULATION SHEET

DRAWING NO.	DESCRIPTION	MAT'L	GAGE	NO. REQ	CALCULATIONS	WEIGHT	X	Y	Z
852579	(CONT.) HOT END					.10	13.2		0
						.12	13.88		
						.05	14.2		
						.01	14.1		
						.08	15.05		
						.09	15.85		
						.03	15.93		
	HEATER (RAM)			1	.15	.18	13.5		
852580	RETAINER, HOT GEN. (PARTIAL)	CRS		1		.03	8.45		
852581	SCREEN, "	"		N/R		.10	10.69		
852582-3	DOME-SHIELD ASSY.	"	.05	1		.14	15.2		
					.01	.57	16.65		
" -5	CYLINDER "	"	.04	1		.121	12.35		
" -7	FLANGE "	"		1		.02	8.91		
						.13	9.09		
						.02	9.28		
					.24	.07	9.47		
" -9	BOSS	"		1		.03	17.35		
" -11	TUBE	"	5/8" .035	1		.13	20.85		
"	B* NUT & SLEEVE	"	.10	1	.25	.12	24.35		
852583-1	RING, RETAINING (PARTIAL)	1/4" 718		1	.42	.11	8.41		
					.5	.18	8.57		
						.01	8.72		
					3.50	.15	8.76	2.4122	0

DATE	CUSTOMER	APPLICATION	TOTAL WEIGHT - DRY
S-23-73	NASA	SPACE	LBS.
PROJ. ENGR.	TITLE		TOTAL WEIGHT - WET
	VILLEUMIER REFRIGERATION ENGINE 1/4 WATT		LBS.
CALC. BY		NEXT ASSY.	PAGE 8 OF 10
NICK LOEWEN		CHANGES	DWG. NO. 851260

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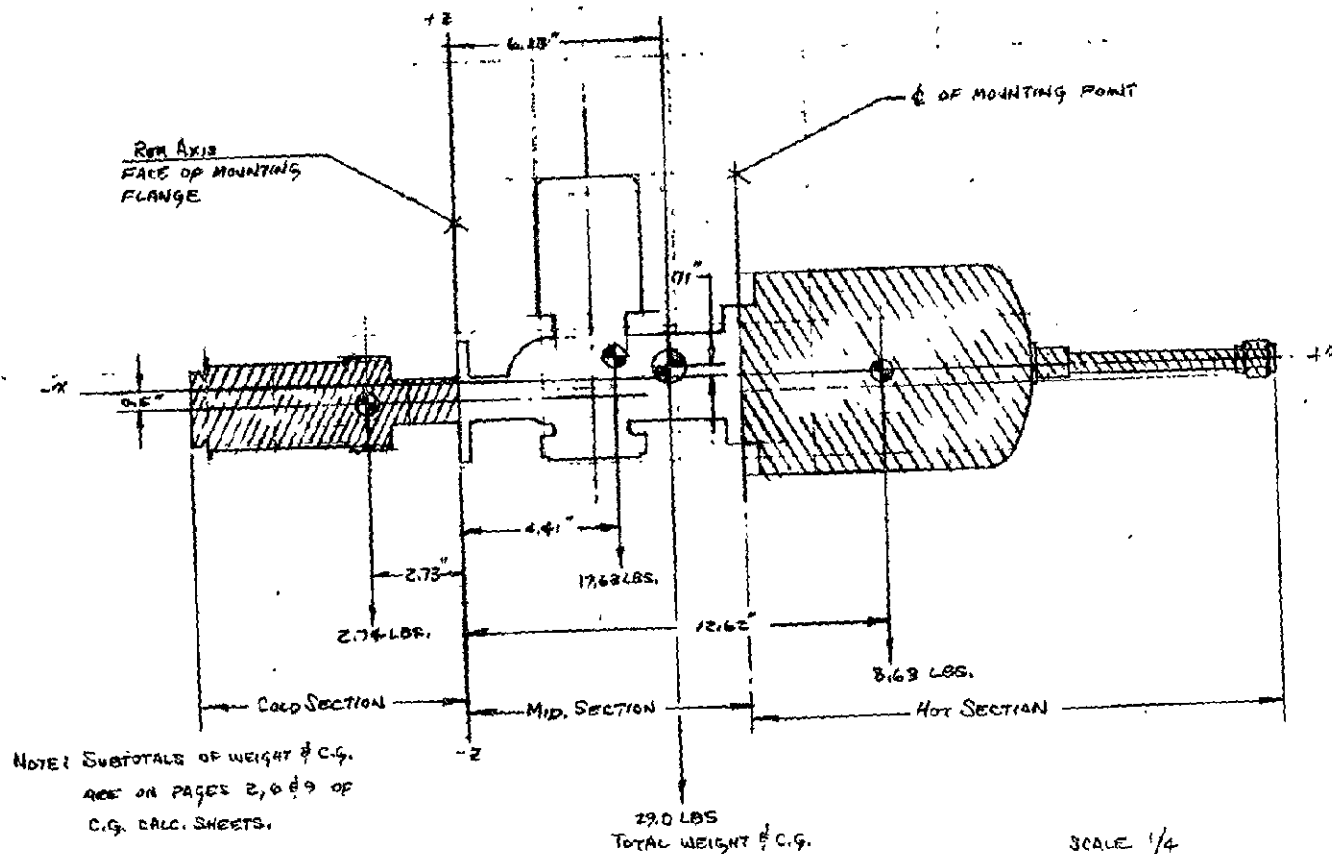


WEIGHT CALCULATION SHEET

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REV. 6-15-73
S-23-73
NICK LOEWEN

VUILLEUMIER REFRIGERATION ENGINE, 1/4 WATT

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APPENDIX B
REFERENCES

APPENDIX B

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